Upgrade OPTIMUS release 2

4512 104 38561

FILING INSTRUCTIONS

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SUBSYSTEM Manual OPTIMUS 50/65/80

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PHILIPS

Philips Medical Systems
Development and Manufacturing Centre

SERVICE MANUAL
742
UNIT

Upgrade OPTIMUS release 2

4512 104 38561

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Manual Order No. 4512 984 04841

SERVICE MANUAL – UNIT

Upgrade OPTIMUS release 2

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Type No: 4512 104 38561

In case there are any questions concerning this manual,
please send this LOPAD via fax to 49/(0)40/5078 2481

File: Upgrade OPTIMUS release 2_960E

List of pages and drawings (LOPAD) **Manual Order No: 4512 984 04841**

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1. Tools required

- Standard tools
- Service PC with serial data cable,
  Windows and mouse required for using the APR Manager

For function upgrade Area Dose Calculation:

- Dose measurement unit, e.g. DALI with measuring cell 77334 or PMX 3

2. Contents of the upgrade package

- 5 PROM's 4512 113 18025/ 18035/ 20204/ 20511/ 20721
- 1 PLCC extraction tool, type AMP 822154–1, code number 2422 487 89772
- 2 capacitors 1nF 2012 573 00015
- 2 capacitors 33pF 2222 682 10339
- 1 Function key (small PROM), labelled with the serial number of the corresponding generator
- 1 additional mastercard (Stammkarte) and 3 copies, marked with the serial number of the corresponding generator
- 1 PCB Basic Interface EZ150, 4512 108 05964
- Service documentation: sections 2 ... 7 and parts lists
- 1 floppy disk 3.5" with the service software XRGSCOPE version 2.12
- 1 floppy disk 3.5" with the APR manager
- 1 help manual with additional information about setting–to–work
- 1 operator's manual
- this upgrade information

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3. Upgrading from release 0.2 or 0.3 to 2.2

The release 0 can be identified by the PROM set D3, D4 and D5 on the PCB EZ139.

Release 0.2: 20702, 18022, 18032

Release 0.3: 20703, 18023, 18033

- Plug the hardware key into your PC and use the new XRGSCOPE version 2.1.
- Connect the PC to the CU board of the generator.
- Read out the following programmings:
  Print the data via the PC feature SCREENPRINT or enter it in the list enclosed.
  - *Mains Data*
  - *Tubes/ Capacitance Tube Connection*
    Tube Speed Selection
    Boost Modes
  - *Registration Devices/*
    RGDV 1...8/ Data Set A
    Data Set B
    RGDV Interface Assignment/ Device Interface 1/ Decade Bucky 1
    Decade Bucky 2
    Tomo Time
- Read out the DRC programmings in the manual mode and store them by pressing the F3 button (SAVE function of XRGSCOPE) either on hard disk or floppy disk.
  - *Dose Rate Control/ Chamber 1...5/ Data Set 1...5*
    Use the file name *ch#d#.tdl*. #=number of chamber or data set
- Read out the number of exposures in the menu "*Accept/ Inspect/ Exposure Counter*" and enter the data in the reference book of the system.
- If more than one film/screen combination is programmed onto one RGDV then record the correlation of the other film/screen combinations (Data Set 2...5) to the specific APR's. In this case you have to select every APR to get information about the correlated film/screen combination. Use the list enclosed.
- Notice the maximum kV the tube(s) was (were) adapted to: ..... kV
- Check the voltage stability of the tube(s).
  To do this release some exposures in the range of 110 kV to 150 kV and about 25 mAs.
  If there are errors, find out the upper kV limit in the error free working zone.
  This limit should be the new adaptation limit: ..... kV
- Make backups of the APR programming with the help of the APR Manager.
  You will get one file that includes all APRs of every RGDV.
  Compare the complete APR structure loaded with that one stored in the control desk.

  APR backups can also be made via the menu "*Accept/ Backup/ RGDV Related Assignments/ RGDV 1...8/ APR Assignments*".

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You must be sure that you have a complete APR backup before starting the next steps!

- Read out the error list in the menu "*Faultfind/ Logging Table/ Error Log/ Error Log Index*".
  Save the list via the F3 button on the PC.
  Please, send this error log (marked with the serial number of the generator) via the
  FAX (number: +49 40 5078 2348) or as on enclosed file via the BBS / Node 320 (Germany) to the Helpdesk in Hamburg.

- Erase the battery buffered RAM on EZ139 CU. To do so put the jumper W2 temporarily in the opposite position for at least 5 minutes.

- Exchange the following PROM's shown in the new drawings 5Z–1 and 5Z–2:

  "serial number" = D38 on EZ139 Central unit, if delivered.
  - the serial number of the chip must match with the serial number of the generator!
  - take notice of the plug–in direction!

  4512 113 20721 = D3 on EZ139 Central unit
  4512 113 18026 = D4 on EZ139 Central unit
  4512 113 18036 = D5 on EZ139 Central unit
  4512 113 20205 = D800 on EZ119 mA control
  4512 113 20511 = D2 on C300 CPU in the operating desk (let the desk be open for the next action)

- Exchange the PCB Basic Interface EZ150.

  Put the PROM D6 labelled with 20301 from the old PCB in the new one.

  Jumper setting:
  - W4 in position 3: Gain factor 1 = low sensitivity, for film/ screen combinations with a speed of 200 or lower.
  - W4 in position 1: Gain factor 4 = high sensitivity, for film/ screen combinations with a speed greater than 200.

- Insert the four capacitors.
  - 33 pF at the CAN chip D808 on EZ119 and EZ130. See drawings Z–2, Z–3.
  - 1 nF in parallel to the termination resistor on the plug EZX52.
  - 1 nF in parallel to the resistor R15 on the desk PCB C300. See drawing Z–1.

- Program the generator. Refer to new section INSTALLATION and HELP MANUAL.
  - *Date and Time*
  - *Mains Data*
  - *Tube 1...3 Data Set*
  - *Tube 1...3 Speed Selection* (checking only)
  - *Tube Limits* (max. kV for adaptation)
  - *Capacitance tube connection*
  - *Tube Operating Modes*
  - *AMPLIMAT Sensitivity*
    Select "low" or "high" in accordance with the hardware setting of EZ150W4.
    "High" is possible with EZ150 ≥ 4512 108 05964 only.
  - *Chamber 1...5/ Data Set 1...5*
    By pressing the <ESC> button you will get the manual mode.
    Press the F4 button and select the previously saved file *ch#d#.tdl* to load the data in the PC.
    With F2 button transmit the datas in the generator.

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- Reset the generator.
- Program the registration devices RGDV 1...8 to be activated.
  - *RGDV 1...8/ Data Set A...B*
  - *RGDV Interface Assignment/ Bucky Tomo 1WA...2WA*

  Take notice of the changing of the contents and the names in the data sets, e.g.:

Mounted Release Circuit	—> Release Circuit Adaptation Unit
Dose Measurement Unit	—> Dose Measurement Input
Multiple Releases during Preparation	—> No Brake after Exposure End

- Reset the generator.
- Adapt the tubes, but small and large focus only and not the VARIOFOCUS as middle focus.
- Reset the generator.
- Program the operating desk.
  - *Select Language*
  - *RGDV Related Assignment/ RGDV 1...8/ Predefined Assignment*

    Select the corresponding backup file and press F2.
- Reset the generator.
- If more than 1 film/screen combination was programmed onto one RGDV than assign the combinations 2...5 to the APR's marked before.

  This can be done by selecting both APR and corresponding film/screen combination on the operating panel. After pressing the reset button and the APR button together this correlation will be stored in the generator.
- If necessary program the new techniques, e.g. fix current kV–mA, for the special APR's.

  See the new service documentation.
- Save all the configuration data as described in the service documentation.
- Mark on the mastercard (Stammkarte) fixed in the generator, the upgrade to release 2.

  Enter the following:
  9890 000 02503 Firmware OPTIMUS, Rel.2 4512 114 20821
- Add the mastercard for the options in case of function upgrade.
- Change the service documentation.
  - Exchange sections 2, 3, 4, 5, 6 and 7
  - Add the parts list based on another logistic structure (type numbers for components of the generator).
- Exchange the floppy disks. The new single floppy disk replaces the two older ones.
- Exchange the operator's manual.
- Check all functions.

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4. Upgrading from release 1.1 to 2.2

The release 1 can be identified by the PROM set D3, D4 and D5 on the PCB EZ139.

Release 1: 20711, 18024, 18034

The upgrade from release 1 to release 2 will be done in principle by a change to the PROMs and an adaption to some programmings.

To prevent a lot of trouble in crash situations it is highly recommended to read out all programmings first.

- Plug the hardware key into your PC and use the new XRGSCOPE version 2.1.
- Connect the PC to the CU board of the generator.
- Read out the following programmings:
  Print the data via the PC feature SCREENPRINT or enter it in the list enclosed.
  - *Mains Data*
  - *Tubes/ Capacitance Tube Connection*
    Tube Speed Selection
    Boost Modes
  - *Registration Devices/*
    RGDV 1...8/ Data Set A
    Data Set B
    RGDV Interface Assignment/ Device Interface 1/ Decade Bucky 1
    Decade Bucky 2
    Tomo Time
- Read out the DRC programmings in the manual mode and store them by pressing the F3 button (SAVE function of XRGSCOPE) either on hard disk or floppy disk.
  - *Dose Rate Control/ Chamber 1...5/ Data Set 1...5*
    Use the file name *ch#d#.tdl*. #=number of chamber or data set
- Read out the number of exposures in the menu "*Accept/ Inspect/ Exposure Counter*" and enter the data in the reference book of the system.
- If more than one film/screen combination is programmed onto one RGDV then record the correlation of the other film/screen combinations (Data Set 2...5) to the specific APR's. In this case you have to select every APR to get information about the correlated film/screen combination. Use the list enclosed.
- Notice the maximum kV the tube(s) was adapted to: ..... kV
- Check the voltage stability of the tube(s).
  To do this release some exposures in the range of 110 kV to 150 kV and about 25 mAs.
  If there are errors, find out the upper kV limit in the error free working zone.
  This limit should be the new adaptation limit: ..... kV
- If a Bucky TH with bucky controller is connected note all APRs stored in the bucky controller too.
- Make backups of the APR programming with the help of the APR Manager.
  You will get one file that includes all APRs of every RGDV.
  Compare the complete APR structure loaded with that one stored in the control desk.
  APR backups can also be made via the menu "*Accept/ Backup/ RGDV Related* Assignments/ RGDV 1...8/ APR Assignments".

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You must be sure that you have a complete APR backup before starting the next steps!

- Read out the error list in the menu "*Faultfind/ Logging Table/ Error Log/ Error Log* Index".
  Save the list via the F3 button on the PC.
  Please, send this error log (marked with the serial number of the generator) via the FAX (number: +49 40 5078 2348) or as on enclosed file via the BBS / Node 320 (Germany) to the Helpdesk in Hamburg.

- Exchange the following PROM's shown in the new drawings 5Z–1 and 5Z–2:

"serial number"	=	D38 on EZ139 Central unit, in case of function upgrade only. – the serial number of the chip must match with the serial number of the generator! – take notice of the plug–in direction!
4512 113 20721	=	D3 on EZ139 Central unit
4512 113 18026	=	D4 on EZ139 Central unit
4512 113 18036	=	D5 on EZ139 Central unit
4512 113 20205	=	D800 on EZ119 mA control
4512 113 20511	=	D2 on C300 CPU in the operating desk (let the desk be open for the next action)

- Exchange the PCB Basic Interface EZ150.
  Put the PROM D6 labelled with 20301 from the old PCB in the new one.

  Jumper setting:
  - W4 in position 3: Gain factor 1 = low sensitivity, for film/ screen combinations with a speed of 200 or lower.
  - W4 in position 1: Gain factor 4 = high sensitivity, for film/ screen combinations with a speed greater than 200.

- Insert the four capacitors.
  - 33 pF at the CAN chip D808 on EZ119 and EZ130. See drawings Z–2, Z–3.
  - 1 nF in parallel to the termination resistor on the plug EZX52.
  - 1 nF in parallel to the resistor R15 on the desk PCB C300. See drawing Z–1.

- Remove the special plug with a diode logic on EWAX22 if present.
  This plug was delivered with the option Automatic Input of Tomo Times and is not needed anymore.

- Program the following. Refer to section INSTALLATION and HELP MANUAL.
  - *Date and Time*
  - *Mains Data*
  - *Tube Operating Modes*
  - *AMPLIMAT Sensitivity* (new menu item)
    Select "low" or "high" in accordance with the hardware setting of EZ150W4.
    "High" is possible with EZ150 ≥ 4512 108 05964 only.
  - *RGDV 1...8/ Data Set A...B*
    Take notice of the changing of the contents and the names in the data sets, e.g.:

Mounted Release Circuit	—> Release Circuit Adaptation Unit
Dose Measurement Unit	—> Dose Measurement Input
Multiple Releases during Preparation	—> No Brake after Exposure End
Mounted Bucky Controller	—> Mounted Radiographical Controller

  - *RGDV Interface Assignment/ Bucky Tomo 1WA...2WA* (if unit WA is present)

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- Reset the generator.
- Adapt the tubes, but small and large focus only and not the VARIOFOCUS as middle focus.
  Do this in the following sequence:
  - Delete the old tube data via the menu "*Program/ Tubes/ Disable Tube*".
  - Load the new tube data via the menu "*Program/ Tubes/ Tubes 1...3/ Tube 1...3 Data Set*".
    During this procedure the CAN interface on EZX43 to Bucky TH must be disconnected if present!
  - Reset the generator.
  - Program the upper kV limit for adaptation via the menu "*Program/ Tubes/ Tube Limits*".
  - Adapt the tube(s) via the menu "*Adjust/ Tube Adaptation*".
- Reset the generator.
- If necessary program the new techniques, e.g. fix current kV–mA, for the special APR's.
  See the new service documentation.
- If the option Area Dose Display is present perform the adjustments via the menu "*Adjust/ Area Exposure Product*".
  This option works in conjunction with Bucky TH with sensing only.
- Save all the configuration data as described in the service documentation.
- Mark on the mastercard (Stammkarte) fixed in the generator, the upgrade to release 2.
  Enter the following:
  9890 000 02503 Firmware OPTIMUS, Rel.2 4512 114 20821
- Add the mastercard for the options in case of function upgrade.
- Change the service documentation.
  - Exchange sections 2, 3, 4, 5, 6 and 7
  - Add the parts list based on another logistic structure (type numbers for components of the generator).
- Exchange the floppy disks. The new single floppy disk replaces the two older ones.
- Exchange the operator's manual.
- Check all functions.

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5. Programming tables

- Mains voltage: .....
- Mains resistance: .....
- Capacitance Tube Connection: tube1: ..... tube2: ..... tube3: .....
- Tube Speed Selection: tube1: ..... tube2: ..... tube3: .....
- Boost Modes/ Intermediate boost: Disabled / Enabled

Device Interface 1	Decade Bucky 1	Decade Bucky 2
Tomo mode switch		
Bucky RGDV– switch related		
Bucky RGDV		
Bucky RGDV		
Tomo RGDV– switch related		
Tomo time 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8		

Device Interface 2	Decade Bucky 1	Decade Bucky 2
Tomo mode switch		
Bucky RGDV– switch related		
Bucky RGDV		
Bucky RGDV		
Tomo RGDV– switch related		
Tomo time 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8		

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Data Set A	RGDV 1	RGDV 2	RGDV 3	RGDV 4	RGDV 5	RGDV 6	RGDV 7	RGDV 8
Room								
Tube								
Mounted release circuit								
Release circuit number								
Enable handswitch ...								
Syncmaster present								
Exposure switch type								
Bucky format dens. ...								
Cone density ...								
Dose measurement unit								
Multiple release ...								
Release delay								
Mounted tomo extension								
Mounted bucky contr.								
APR extension ...	No	No	No	No	No	No	No	No
PSC extension ...	No	No	No	No	No	No	No	No

Data set B	RGDV 1	RGDV 2	RGDV 3	RGDV 4	RGDV 5	RGDV 6	RGDV 7	RGDV 8
Used for tomography								
Disable time input ...								
Tube power usage								
U step rate								
Q step rate								
I step rate								
t step rate								
Density step rate								
Density correction	0	0	0	0	0	0	0	0
Under exposure display								

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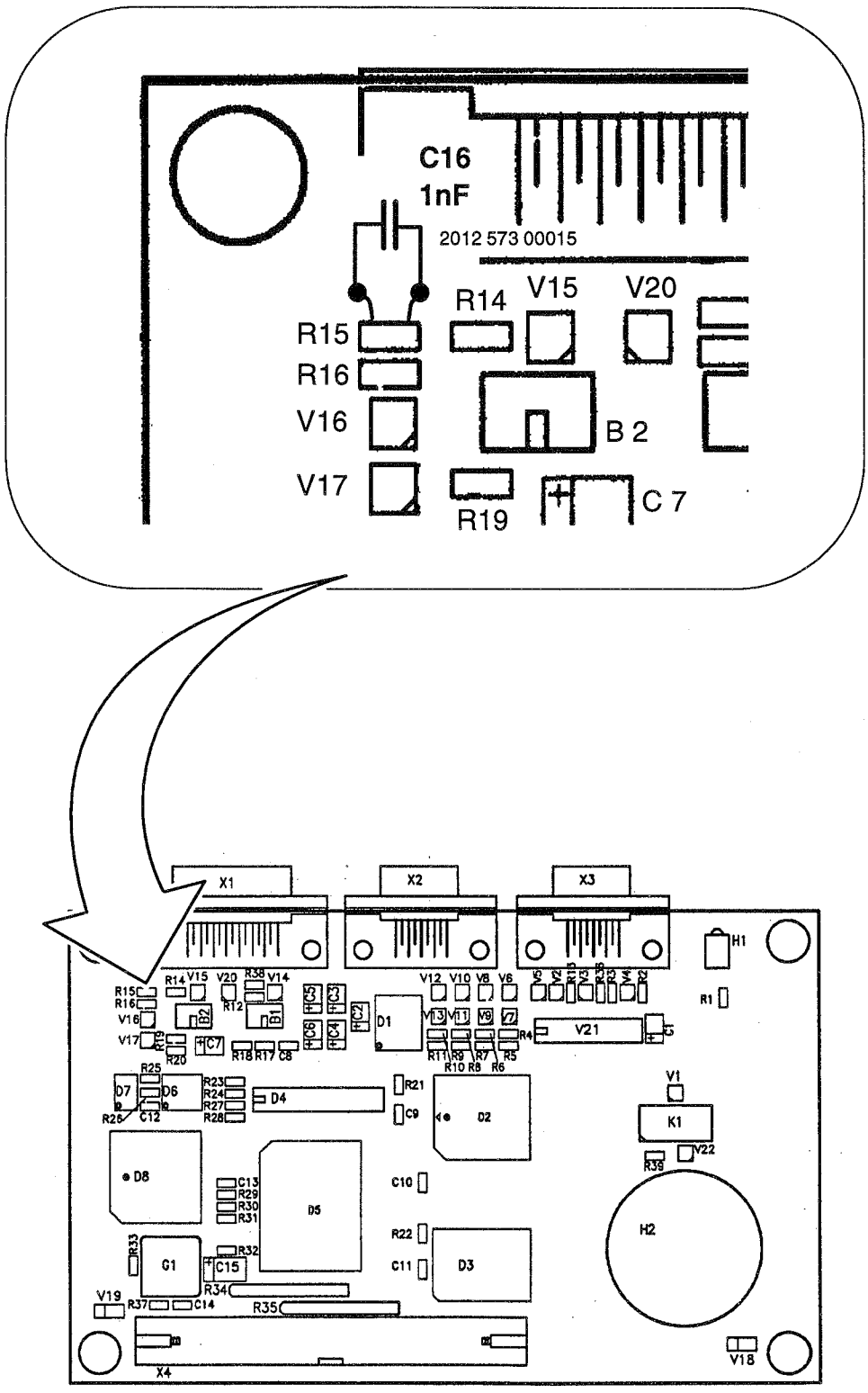
Correlating APR's and film/screen combinations:

(Necessary for 2nd, 3rd, 4th and 5th combination of each measuring unit only.

The first combination will be assigned automatically to each APR loaded into the generator)

RGDV #	name of film/screen combination	APR menu name	APR name

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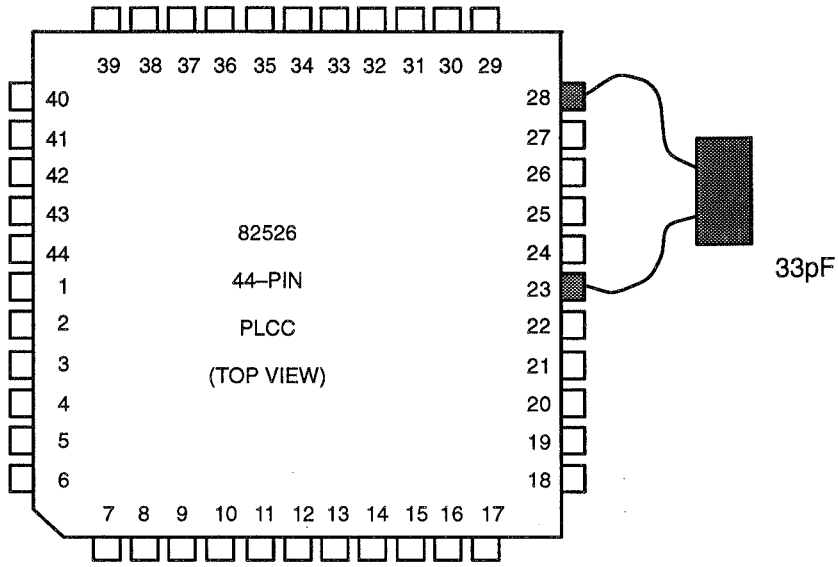


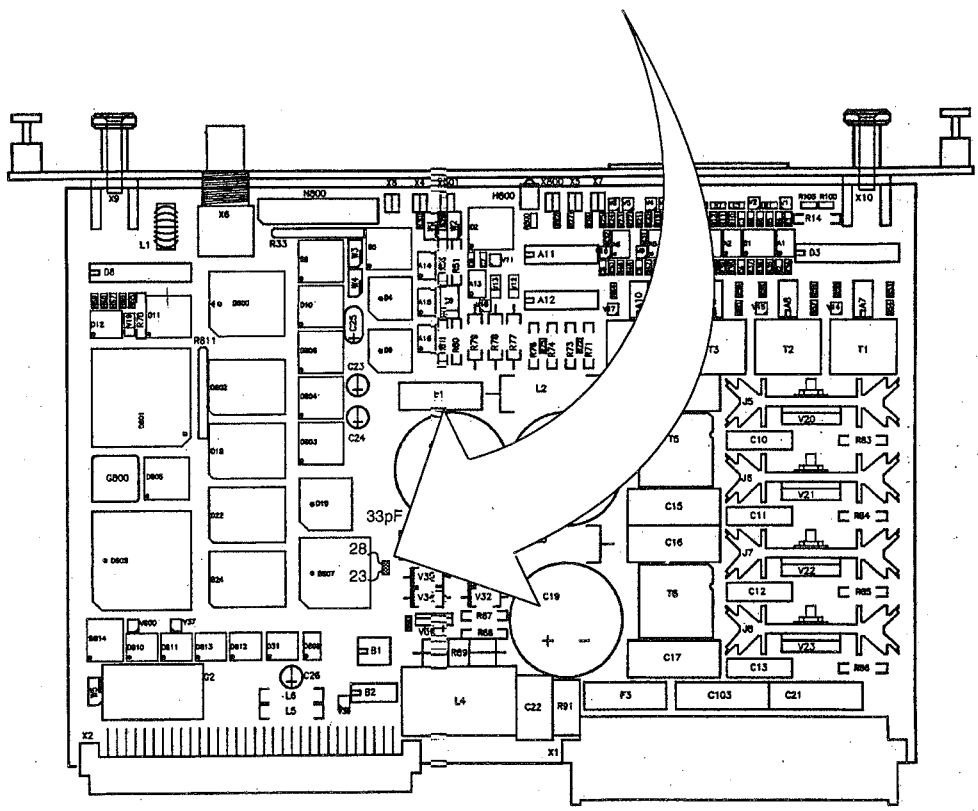
A4 96–06–13 Re

Upgr OPTIMUS rel 2_Z–1

C 300
PCB modification
Desk CPU

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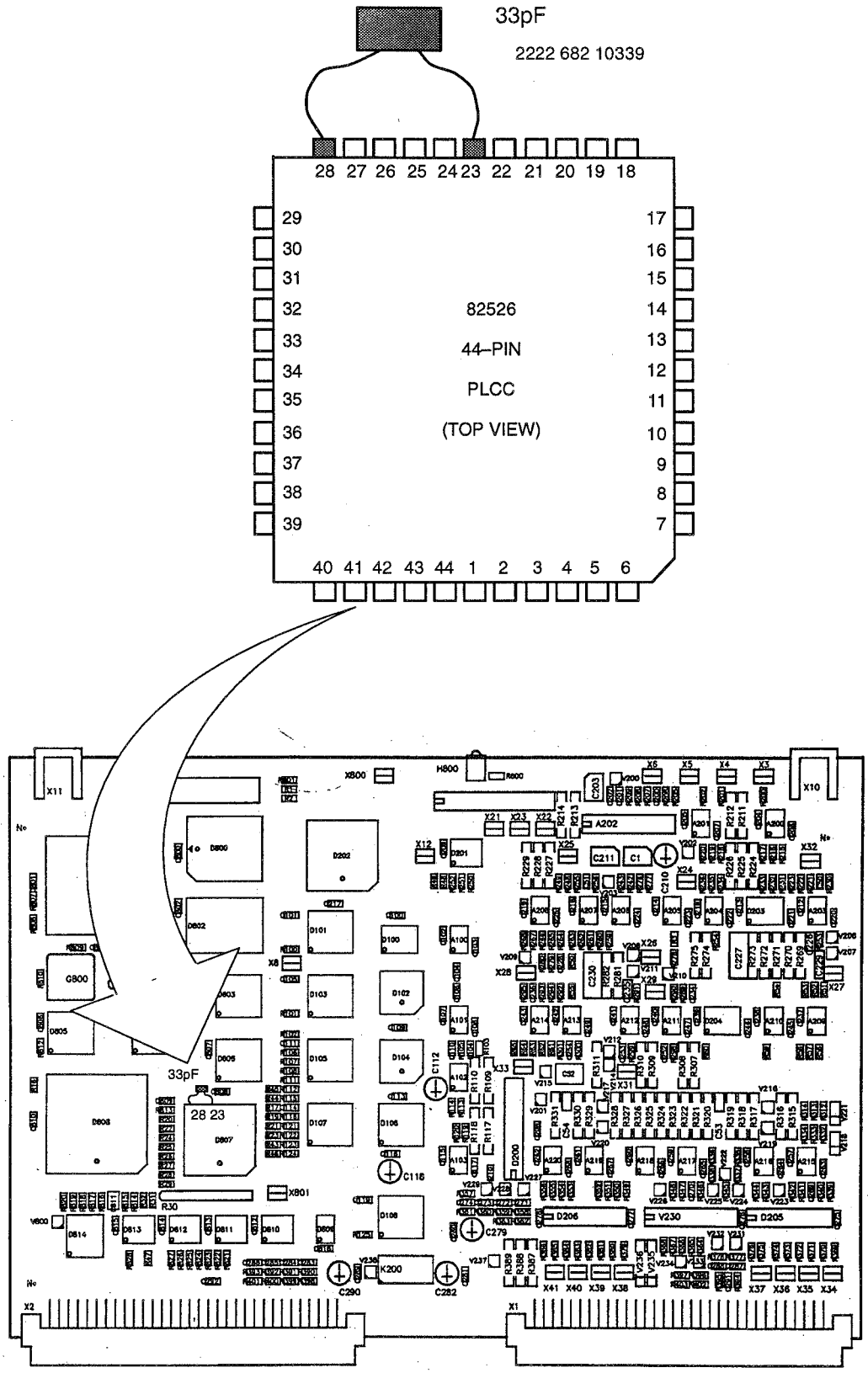


A4 96–06–13 Re

Upgr OPTIMUS rel 2_Z–2

EZ 119
PCB modification
MA control

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A4 96–06–13 Re

Upgr OPTIMUS rel 2_Z–3

EZ 130
PCB modification
kV control

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INSTALLATION

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DRAWINGS

Labelling 2Z–1

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1. Installing the wall junction box

- Mount the wall junction box at the place where the generator is intended to be installed.
  (See drawing Z-3 in section 1 and manual UNIT 4512 103 75380 for wall junction boxes).
- If necessary, install the optional Surge Arrester WN inside the wall junction box.
  To do this see Surge Arrester documentation.
- If applicable, mount the filler panels of the generator to the wall junction box.
- Have the mains cable present at the clinic connected to mains terminal MEX by a person who is authorized for this job.
- Check the phase sequence of L1, L2 and L3.
- Switch off the mains supply present at the clinic and make sure that it cannot be switched on again by anyone who is not authorized to do so.

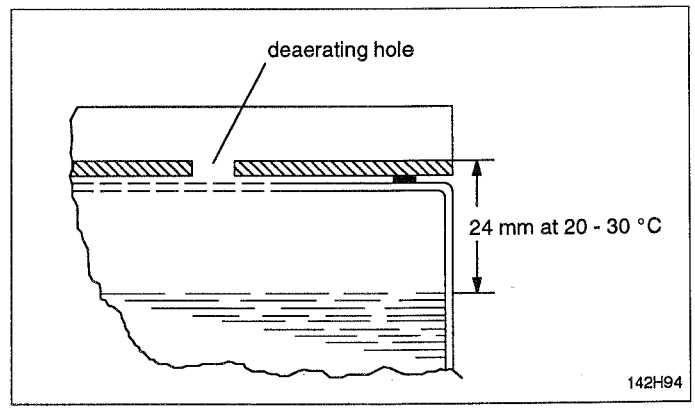
2. Mounting the H.V. generator in the cabinet

Caution!

Do not tilt the H.V. generator when transporting it!

In case a tilting angle of greater than 45° has been exceeded, the setting-to-work of the generator can be started not before a waiting time of about 8 hours has passed. Otherwise the H.V. generator may be destroyed by electrical sparkover!

- Unpack generator cabinet E.
- Unpack the H.V. generator.
- In case the packing material is strongly soiled with oil, check the oil level and, if necessary, correct.
  Watch that no foreign matter falls into the oil! Otherwise the transformer must be exchanged!
  Tolerance: ±2 mm
  Oil: Shell Diala G in 2.5 l container 4512 148 43172



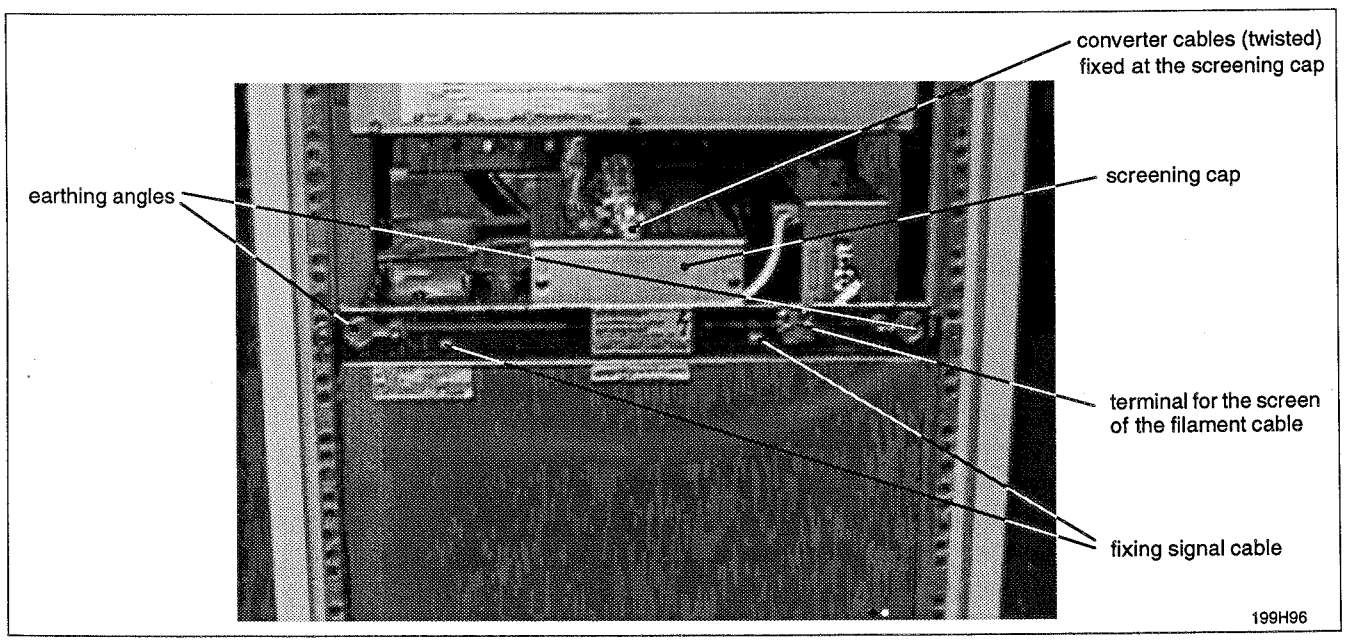
- Take the two transport bars from the rear side of the cabinet.
- Lift the H.V. generator into the generator cabinet with the transport bars.
  The 4 connecting bolts GX1001 to 1004 must point towards the front of the generator cabinet.
- Loosen the deaerating screw by turning it 3 times counter-clockwise.

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- Connect the H.V. generator electrically.

Always:	– E1 ⏚	———	GX1100 (ground)	
	– ZX12	———	G100X15	Route the cables along the front and left-hand edge of the H.V. generator and fix them!
	– ZX35	———	G100X14	
50 kW version:	– QC13:1	———	GX1003	Twist the cables! Bear in mind that the connecting bolts are not arranged in numerical order. After connecting up, push the screening cap forward over the connecting bolts and tighten up. Attach the converter cables including the screening to the screening cap with cable ties.
	– QC 3:1	———	GX1002	
65/80 kW version:	– QC13:1	———	GX1001	Twist the cables! Bear in mind that the connecting bolts are not arranged in numerical order. After connecting up, push the screening cap forward over the connecting bolts and tighten up. Attach the converter cables including the screening to the screening cap with cable ties.
	– QC 3:1	———	GX1002	
	– 2QC13:1	———	GX1003	
	– 2QC 3:1	———	GX1004	
2nd tube:	– WGX61	———	GK1:1	
	– WGX67	———	GK1:2	
	– WGX62	———	GK2:1	
	– WGX68	———	GK2:2	

- Fold the two earthing angles of the H.V. generator outward and screw it on to the members of the cabinet.



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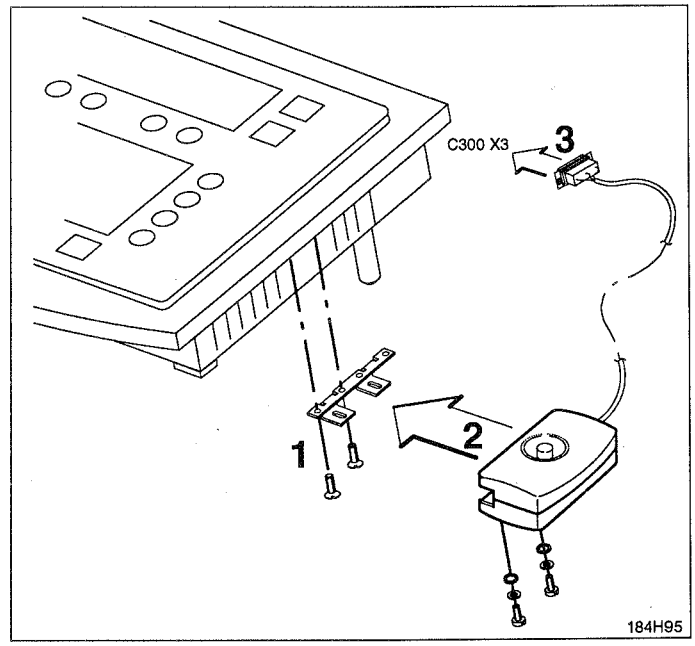
3. Installing the operating panel

3.1. Desk version

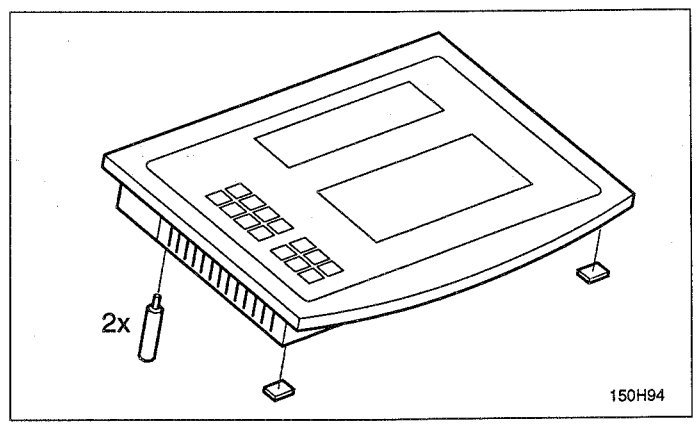
Accessories:

- 2 feet for the unit
- 2 elastic buffers, black
- 5 insert strips for the RGDV buttons
- sheet with RGDV symbols
- release switch

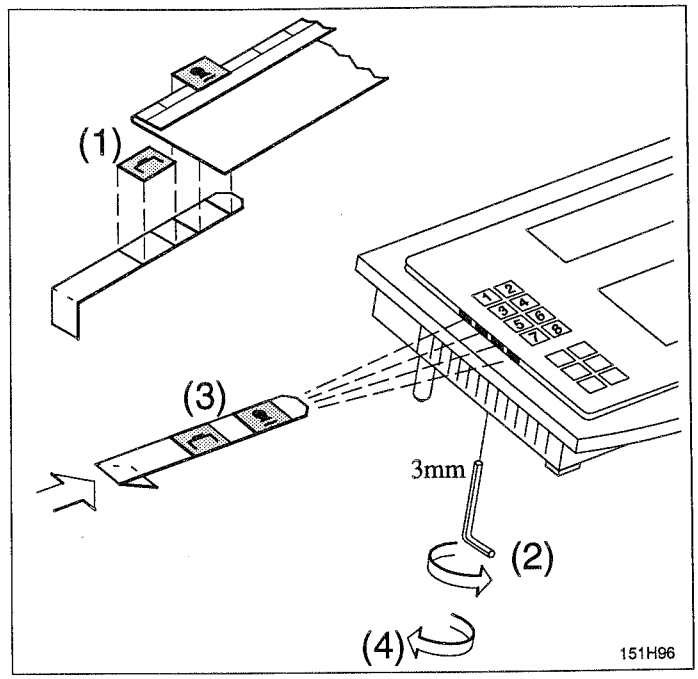
- Carefully unpack the desk.
- Mount the release switch on the left-hand or right-hand side of the desk.
  - Using the two M4x10 countersink screws attach the holding bracket to the edge of the desk (1). For visual reasons the release button should be in line with the +/- buttons on the control desk so please use the appropriate holes in the bracket.
  - Slip the release switch over the edge of the desk and fasten in position using the two M4x10 cheese-head screws, securing rings and washers (2).



- Screw in the 2 feet for the unit at the bottom of the desk.
- Glue the 2 black elastic buffers to the front edges of the bottom of the desk such that they are acting as the front feet.



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- Define the assignment of the RGDV buttons 1...8 and glue the respective symbols to the insert strips which are provided with subsidiary lines (1).
- Raise the keyboard from the bottom of the desk about 5 mm with an Allen key, 3 mm across flats (2).
- Push the insert strips under the keyboard foil. Press the angulated, protruding end of each insert strip into the housing of the desk (3).
- Lower the keyboard (4).
- Screw off the cable cover at the rear side of the desk..
- Connect the cables:
  - Supply cable EZX20 – C200X1
    EZX6 – earth
  - Data cable EZX46 – C300X1
  - Release switch – C300X3
  - Patient Data Organizer – C300X2 (option)
- Provide drag relief for the supply and data cables with the clamp present on the desk.
- Screw on the cable cover. Make sure that the cable strain relief device of the release switch (1 cable tie) remains under the cover.

3.2. Stand version

See Z-5 "Operating panel" in section 1.

Additional accessories:
- 4 dowels S10
- 4 hexagon cap screws 8 x 60 mm
- 4 washers

- Position the desk stand according to the respective room layout.
- Mark the fixing holes on the floor.
- Set the 4 dowels supplied into the floor (drill bit: 10 mm).
- Screw on the desk stand with 4 screws (13 mm across flats) and washers.
- Route the supply and data cables from the bottom to the top in the desk stand and provide the cables with drag relief. Cable ends including plugs should protrude beyond the edge of the desk by about 500 mm.
- Mount the release switch as described under 3.1.
- Assign the RGDV buttons 1...8 with the desired symbols as described under 3.1.
- Connect the cables to the desk as described under 3.1.
- Screw on the cable cover. Make sure that the cable strain relief device of the release switch (1 cable tie) remains under the cover.
- Attach the operating panel on the stand.

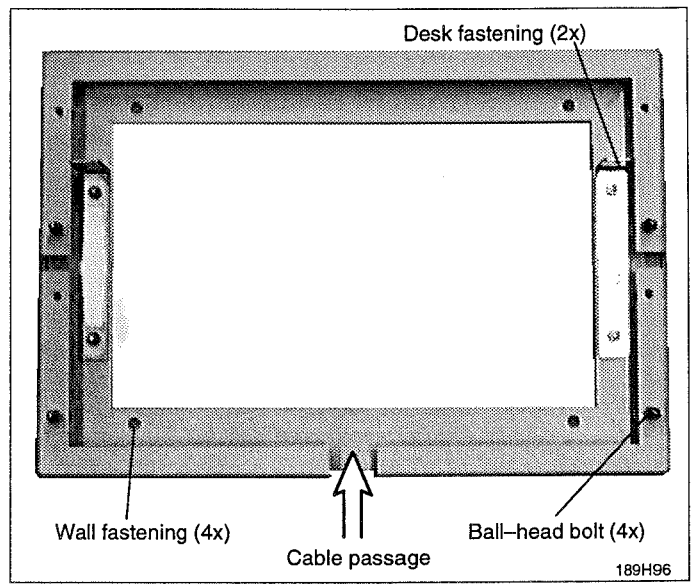
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3.3. Wall mounted version

See Z-5 "Operating panel" in section 1.

Additional accessories:

- 4 ball-head bolts
- 4 dowels S8
- 4 hexagon cap screws 5 x 30 mm
- 4 washers
- 2 screws 4 x 10 mm
- 2 angle plates
- 4 nuts



- Screw the angle plates into the wall frame.
  The short ends of the angles must be pointing upwards.
- Screw the 4 ball-head bolts into the wall support.
- Mark the 4 fixing holes of the wall frame at the respective place on the wall.
- Set the dowels supplied into the wall (drill bit: 8 mm).
- Screw on the wall frame with 4 screws and washers.
- Provide drag relief for the supply and data cables in the wall frame. Cable ends including plugs should protrude beyond the edge of the desk by about 500 mm.
- Mount the release switch as described under 3.1.
- Assign the RGDV buttons 1...8 with the desired symbols as described under 3.1.
- Connect the cables to the desk as described under 3.1.
- Attach the operating panel on the wall frame and fix it with two screws.
- Screw on the cable cover. Make sure that the cable strain relief device of the release switch (1 cable tie) remains under the cover.

The wall frame is of symmetrical design. If surface-mounted cables to be connected come from above it can be fitted upside down. The ball-head bolts and the angle plates must then be fitted appropriately at different positions.

3.4. Additional release switch

An optional second release switch is supplied with a longer spiral cable. The scope of delivery includes various wall hooks and an adapter cable. Electrical connection is made in parallel with the existing release switch which is mounted on the desk itself. To do this, plug the pins of the adapter cable into the D-Sub connector of the existing release switch.

Sequence: Adapter connector pins 1-2-3 to D-Sub connector pins 6-9-7

Reference: Drawing Z1-11.1

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4. Electrical connection

4.1. Earthing

See Z-7.4 "Earthing diagram" in section 1.

4.2. Mains connection

See Z-7.1 "Connection diagram" in section 1.

- Measure the internal mains resistance at the terminal MEX or WNX1100 (option Surge Arrester) with a suitable measuring instrument.

  L1-L2: R_i= ..... mΩ

  L1-L3: R_i= ..... mΩ

  L2-L3: R_i= ..... mΩ

  Required max. mains resistance at generator input (without Surge Arrester WN):

Mains voltage	30 kW	50 kW	65/80 kW
190 V *		40 mΩ	-
220 V *	130 mΩ	60 mΩ	-
240 V *	160 mΩ	80 mΩ	-
400 / 440 / 460 / 480 V	500 mΩ	300 / 350 / 350 / 400 mΩ	200 / 240 / 240 / 300 mΩ

* with external mains transformer

Maximum permissible internal mains resistance: 500 mΩ

Internal resistance of Surge Arrester WN: 20 mΩ at 50 Hz
23 mΩ at 60 Hz

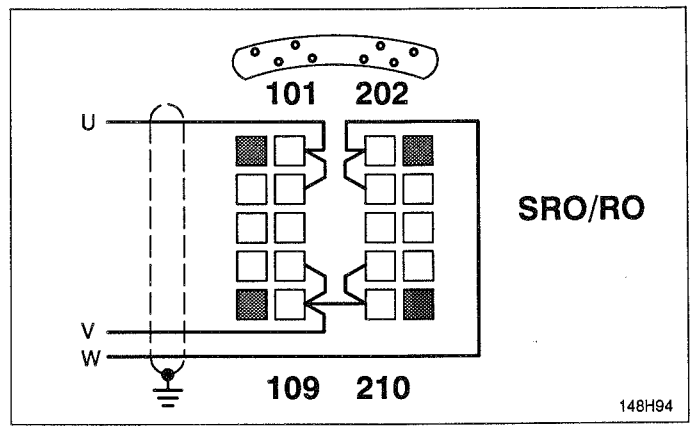
- Switch off the mains supply present at the clinic.
- Connect the mains cable of the generator to terminal MEX:L1/L2/L3 at the wall taking care that the phase sequence is correct.
  If the optional Surge Arrester WN is fitted, connect the cables at that point up to terminal WNX1100.
- Connect the examination unit supply (max. 5 A) to terminal MEX:T1/T2/T3.

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4.3. Stator connection

At the tube end:

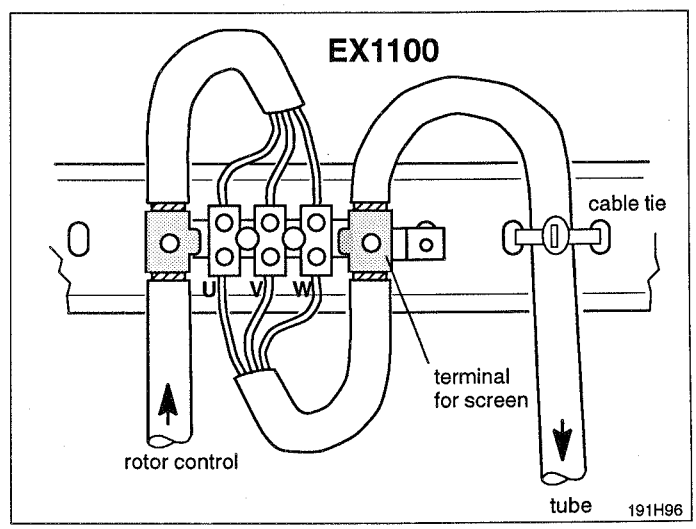
- Place the jumpers across terminals 100 and 200 accordingly.
- Connect up stator cable.
  Use wire 1 for phase U,
  wire 2 for phase V,
  wire 3 for phase W.
- Earth the screening of the stator cable in the tube housing.



At the generator end:

See Z-7.1/2 "Connection diagram" in section 1.

- Connect the stator cable to the terminal EX1100 (U-V-W) or the stator contactors of the tube extension EWG if present.
- Check the stator connection by measuring resistance.
  U-V = wire 1 - 2 ≈ 11 Ω
  U-W = wire 1 - 3 ≈ 20 Ω
  V-W = wire 2 - 3 ≈ 9 Ω
- Relieve the tension on the stator cable with a cable tie.



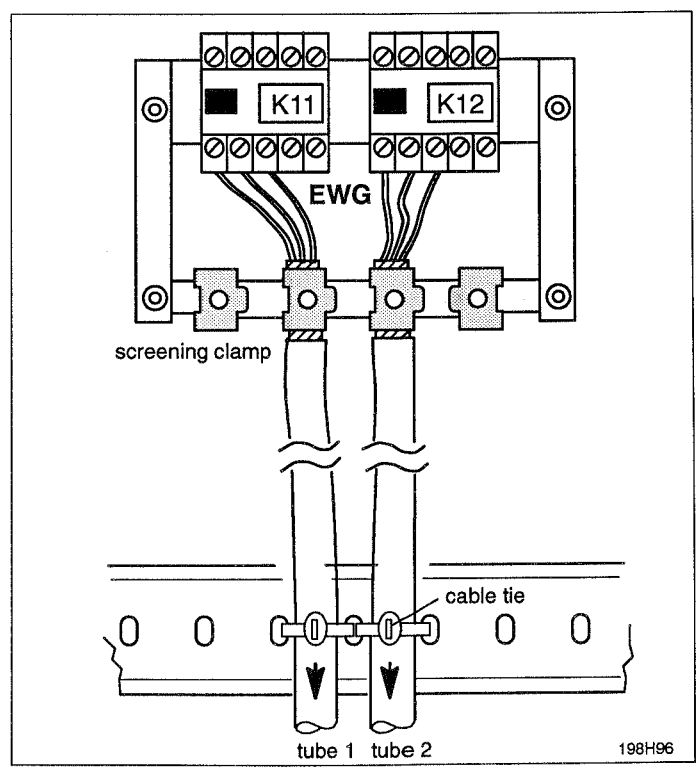
Note

– *Use screened cables. Connect the screen to earth at both ends.*

– *Do not mix up the phases, for otherwise components of the rotor control may be destroyed.*

– *Shorten the stator cable to the required length. Do not accommodate excess lengths at the generator.*

– *Keep stator cable separate from all the other signal cables to avoid interference.*



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4.4. Signal cables

See Z-7.1/2/3 "Connection diagram" in section 1.

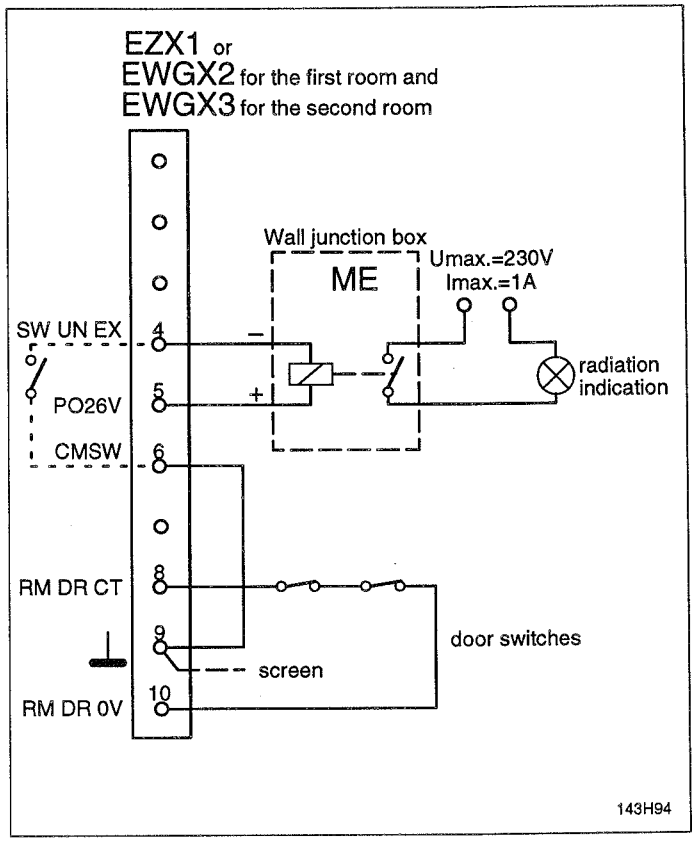
4.4.1. Room decade cable

- Connect the door switches at the generator.
  If none present, link pins 8 - 10.
- In case of need connect an external relay for each examination room to control external radiation warning devices.

  One relay inclusive cable is part of delivery.

  A mounting place is reserved on the mains connection terminal MEX of the wall junction box.

  Make sure the polarity of the relay is correct.



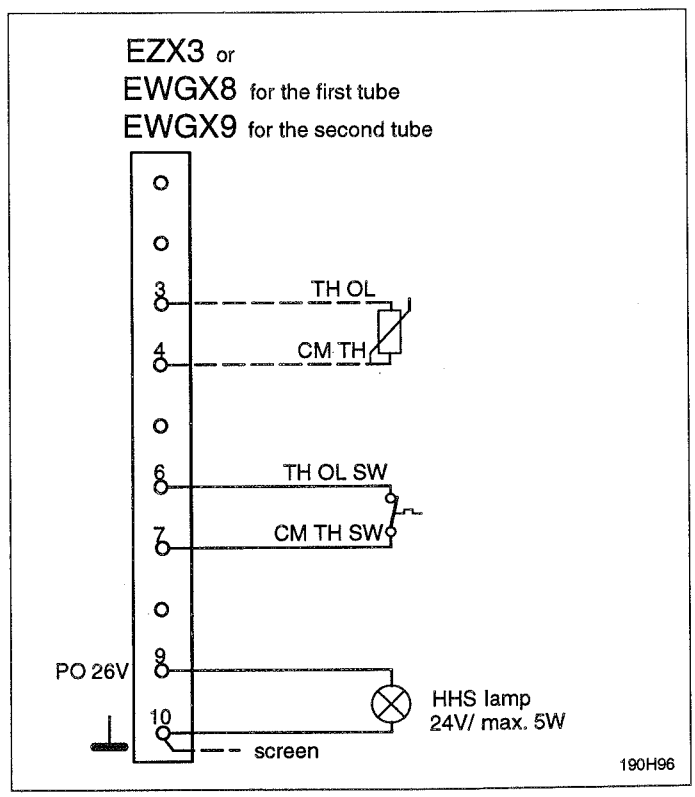
4.4.2. Tube supervision

- Connect the thermal switch or the thermal sensor of the tube housing assembly.
- For U.S.A. only:

  Connect the so-called HHS-lamp to indicate the selected tube housing assembly.

Note

Generators with the older back panel EZ, code No. 4512 108 05983, have the thermal switch connected to pins 3 and 4. If the connection is not correct or if there is an earth short the error "00TB" will appear.



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4.4.3. CAN interface

For examination units which are provided with a CAN system interface.

- EZX 23 - signalbus
- EZX 43 - system CAN

4.4.4. Adapter for 4 auxiliary units

For examination unit which provide their control signals separately via decade cables.

Each of the release circuits and bucky decades can be assigned to one or several of the RGDV buttons 1...8 via software programming.

Survey: Z-7.3 "Connection diagram"
Z1-1.2 "Block diagram, expansions"

Detail: Z1-15.1 "Adapter 4 aux. units"

Information about assignment of the bucky decades WAX11/12:

- The Bucky decades only have to be assigned if any of the following inputs are to be used:

1–2 format contacts	Switch the external measuring fields ON/OFF
3–4 tomo mode	bucky – tomo switchover
5–6 tomo ready	tomo condition met
9–10 bucky ready	bucky condition met

- The inputs are only activated by SW programming (see 9.5).
- After activation via the SW any missing inputs must be simulated by jumpers.
  Example:
  Format contacts on WAX11/12:1–2.
  The outer measuring fields can only be selected in the closed state.

4.4.5. Measuring chamber

- Connect the measuring chambers to the D-Sub connectors EZX21/22/31/32/41.
  There are no restrictions on assignment because the measuring chambers are assigned to the auxiliaries in SW programming.
- At the junior/extremity measuring chamber withdraw pins 101–102–103 or A–D–H for measuring field selection.
  These measuring chambers have only one measuring field. The terminal for the left-hand field is used in other configurations for switching over intensification and must not be connected up here.

AMPLIMAT cables which are provided with a 3-PLUS-connector can be connected up using the adapter connectors supplied.

Detail: Z1-6 "Basic interface"

4.4.6. Patient Data Organizer PDO (option)

See UNIT manual Patient Data Organizer.

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4.5. H.V. cables

See Z-7.1/2 "Connection diagram" in section 1.

- Mark the H.V. cables at the generator and the tube end with the correct polarity.
- Fix the H.V. cables on the left-hand side of the wall junction box on the middle rail for providing drag relief for the cables. The short ends of the H.V. cables which are going to the H.V. generator must be routed in downward direction in this area.

  The free cable lengths including plugs should be about 1.5 m.
- Twist the H.V. cables counter-clockwise by one turn and connect them to the H.V. generator.

  The twisting of the cables provides that the H.V. cables can be put into a loop when the cabinet is placed against the wall.

  The H.V. sockets should always be filled with some oil. At least the lower half of the plugs must be wet with oil.

  Do not fit a silicone washer.

  Do not rub them with silicone.

Notes

- *The union nuts of the high-voltage connectors must be tightened up to ensure good electrical contact for screening.*
- *Only high-voltage connectors which have threaded flange halves may be used. Older high-voltage cables still have connectors where the flange halves are kept together with a spring washer.*
  In such cases the modification kit 4512 103 80852 will be required.

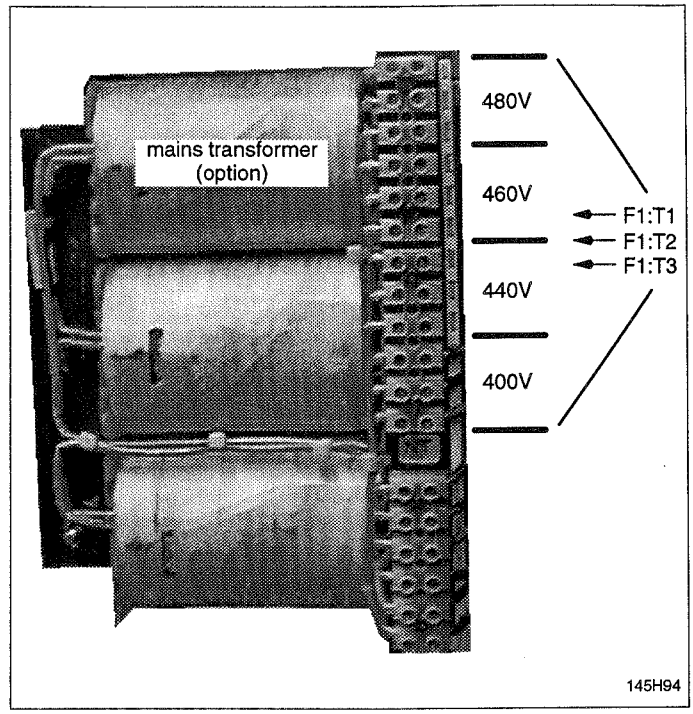
4.6. EMERGENCY-OFF circuit

- Connect the EMERGENCY-OFF buttons to EZX4:1/2.
  If not necessary, link pins 1 - 2.

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5. Hardware programming

- In case mains transformer 9890 000 02301 is present in the generator, connect the primary end according to the rated voltage of the mains.
  Connect 415 V mains systems up to the 400 V terminal.
- Modify filters in the converter assemblies EQ/E2Q if the generator is operated via the optional Surge Arrester on a grounded or floating delta mains.
  See service documentation for Surge Arrester.



On PCB EZ150 Basic interface:

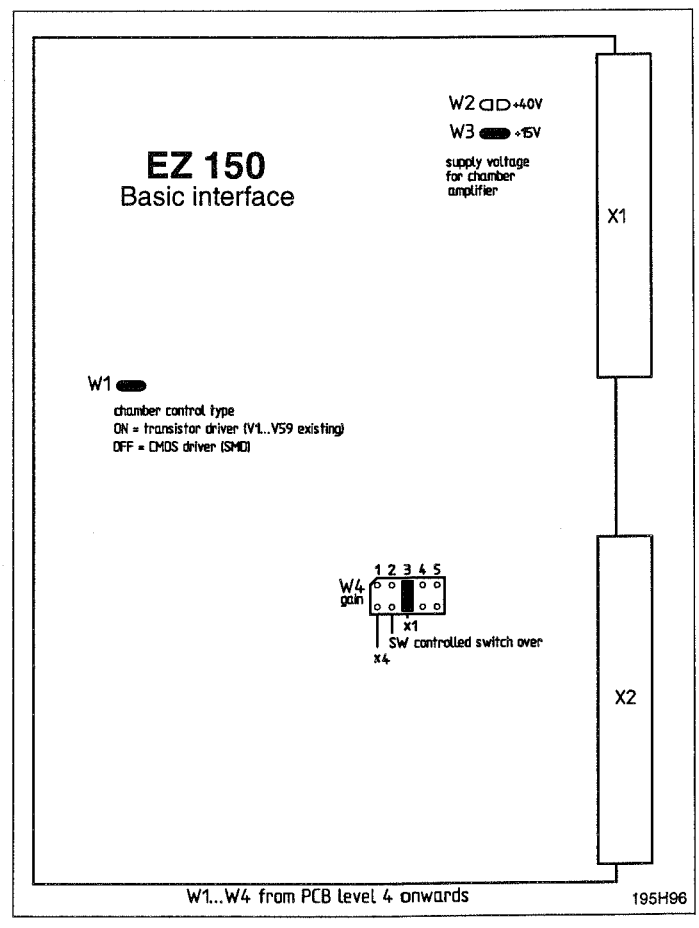
- Voltage supply for the amplifiers of connected measuring chambers:

Voltage\Soldering link	EZ 150 W2	EZ 150 W3
15 V default	OFF	ON
40 V	ON	OFF

  - Working voltage range for ALC measuring chambers: 15 ... 45 V
  - Working voltage range for Hybrid measuring chambers: 40 ... 45 V

  ALC measuring chambers can be recognized from the code No. 4512 104 xxxxx, hybrid measuring chambers based on code No. 4512 102/103 xxxxx.

- Set gain factor for AEC techniques with jumper EZ150:W4:
  - Factor 1 = W4 in position 3 = default
    For film/screen combination with a system speed of 200 or less.
  - Factor 4 = W4 in position 1
    For film/screen combinations with a system speed of at least 200.



The rest of the generator hardware has been properly programmed at the factory.

If required, refer to section "Programming".

6. Switching on the generator

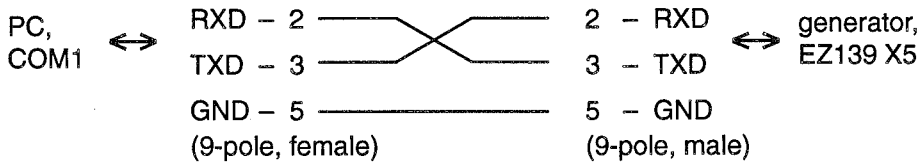
- Switch on the fuses present at the clinic.
- Switch on automatic circuit-breakers ENF1, ENF2 and ENF3.

  The yellow LED on EN100 POWER ON CIRCUIT must be illuminated.

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7. Using the installation software XRGSCOPE

- Provide the service PC with the hardware key and switch it on.
  The hardware key provides access to special program settings and to menu ***"Faultfind"***.
  Standard programming is possible without a hardware key.
- Switch the generator on.
- Connect the PC to X5 on EZ139 CENTRAL UNIT CU via a serial data cable.



- Insert the installation disk in the PC.
  We recommend that the program be stored on hard disk (e.g. with DOS - command xcopy).
- Call the installation program with ***xrgscope*** or ***xrgscope lcd*** for PCs with LCD screen.
  The following menu line appears:

File	***OPTIMUS***	***Select Unit***	***Options***	***Help***

- Select "OPTIMUS".
  The following menu line appears:

Program	***Adjust***	***Accept***	***Faultfind***	***Quit***

General information:

– Button F1	<help>	Call help/cancel help.
– Button F2	<transmit>	Store screen contents/data set in the generator ⇒ transmit to generator.
– Button F3	<save>	Store data set on disk; the path desired can be selected.
– Button F4	<load>	Load data set from disk.
– Button Esc		Commands one step back; can be used repeatedly.
– Fields with ↓		Select the possible range of values with the RETURN button = ↵. The data are specified by the generator as fixed values.
– Fields with [...]		Input of data via the keyboard.

Error numbers which appear at the beginning of the programming procedure must be erased from the screen with the RETURN button.

Note

- *Current data files, for instance, for online help, tube types, APR programming are available in BBS.*
  Product: Generatoren Hamburg
  Download area: OPTIMUS
- *If you call the installation program with **xrgscope ?** the possible starting parameters for the service program will be listed.*

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8. Setting-to-work overview

This overview shows in what order the programming of a generator should take place.

The methods of programming are described in the following sections.

- Generator ON
- Program ... *Date and time*
  Mains data
  Tubes
- Reset the generator *with ON button at the desk or S1 on PCB EZ139*
- Program ... *Dose Rate Control/ AMPLIMAT/ Chamber 1...5/ Data set 1...5*
- Reset the generator
- Program ... *Registration devices/ RGDV 1...8/ Data set A ... B*
  Registration devices/ RGDV interface assignment
- Reset the generator
- Conditioning the tube
- Adjust ... *Tube adaptation (all foci)*
- Reset the generator
- Program ... *Application limits*
- Reset the generator
- Program ... *Human interface/...* —> *All changes will be visible after a reset*
  ... /Select language
  ... /RGDV related assignment/ RGDV 1 ... 8/ Predefined assignment
- Reset the generator
- Density correction *Dose Rate Control/ AMPLIMAT/ Chamber 1...5/ Data set 1...5* - manual programming
- Adjust ... *Area Exposure Product/...*
  .../ Specific yield of tube 1...3
  .../ Add filter correction tables
  .../ Wedge filter correction tables (not used at time)
- Accept... *Backup*

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9. Configuration

9.1. Date and time

- Select menu *"Program/* ***Date and Time****"*.
- Enter the respective local data.

9.2. Mains data

- Select menu *"Program/* ***Mains Data****"*.
- Select the nominal value of the mains voltage U. Range: 380 V, 400 V, 440 V, 480 V Default: 400 V
  If 460 V is present program 480 V.
  If 415 V is present program 400 V.
- Enter the maximum internal mains resistance R_i. Range: 0...500 mΩ

Depending on the internal mains resistance and the mains voltage the generator calculates the maximum possible output.

9.3. Tubes

9.3.1. Tube data set

Note
During this procedure the CAN interface on EZX43 must be disconnected if present (THORAVISION or Bucky TH with bucky controller).

- Select menu *"Program/ Tubes/ Tube 1...3/* ***Tube 1...3 Data Set****"*.
- Start the displayed file *tube.tdl* with <Return>.
  All the permitted combinations of tube type and housing type are listed in a window.
- From the list select the respective combination of tube type and housing type and press <Enter>.
- Reset the generator with the ON button at the desk or button S1 on PCB EZ139.
  Then the data which have been configured up to now are read by the processor when the system is started.

9.3.2. Tube speed selection

Depending on the type of tube loaded the set speed for the anode is programmed automatically.

Modifications, if necessary, may only be performed if a hardkey is used on the PC.

Caution!
Wrong programming could destroy the rotor control unit.

- Select menu *"Program/ Tubes/ Tube 1...3/* ***Tube 1...3 Speed Selection****"*.

RPM \ tube type	RO	SRO
Exposure rotation [RPM]:	3000	9000
Fast Exposure rotation [RPM]:	0	5600
Fluoroscopy rotation [RPM]:	0	3000

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9.3.3. Tube limits

- Select menu *"Program/ Tubes/* ***Tube Limits****"*.
- For each tube connected, program the maximum working voltage which is indicated on the data label:

  Max. Tube Voltage Limit: default: 150 kV range: 40...150 kV

  Adaptation of the tube is up to this limit.

  If older tubes are to be operated on this generator, it is urgently recommended that the maximum kV used in practical operation so far be specified instead of the theoretically possible value.

  After adaptation of a tube the upper kV limit is displayed for each focus of each tube under:

  Adapted to [kV]: e.g. 125

All the other limit programmings are performed by the generator automatically and do not usually have to be observed.

9.3.4. Capacitance of tube connection

- Select menu *"Program/ Tubes/* ***Capacitance tube connection****"*.
- The total capacitance for each tube connected is indicated.

$C = \frac{1}{2} (C_{H.V.\ generator} + C_{H.V.\ cable})$

$= 4.550$ nF Default for H.V. generator + 20 m H.V. cable (155pF/m)

$C\ [nF] = 3 + \frac{C_c \times L}{2000}$ C_c = specific cable capacitance in [pF/m]
L = single cable length in [m]

Example for "capacitance tube connection" in [nF]:

L[m] single length	for 155 pF/m cable	for 200 pF/m cable
14	4.085	4.400
16	4.240	4.600
18	4.395	4.800
20	4.550	5.000
22	4.705	5.200
24	4.860	–
26	5.015	–
28	5.170	–
30	5.325	–

The high-voltage cables type 9806 402 6xx02 currently being supplied have a capacitance of 155 pF/m.

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9.3.5. Tube operating modes

- Select menu *"Program/ Tubes/* ***Tube Operating Modes***".
  - Intermediate boost:

    Select ... Disable = During preparation the rated filament current is applied (default).

    Enable = During preparation a reduced filament current is applied.
    After the release of exposure boosting takes place for a short time before the exposure is released. Effective with tube currents > 80%.

  - Rotation prolongation after PREP:

    Disable = The tube is braked as soon as Preparation has been cancelled.

    Enable = After cancellation of Preparation the tube is only braked after 30 s. Within this time Preparation can be repeated as often as necessary. Recommended for paediatrics. Only with High Speed Rotor Control.

9.3.6. Disable tube

For correction of the configuration.

- Select menu "*Program/ Tubes/* ***Disable Tube***".

When the tube is disabled the above stored data set of the tube is erased. To enable the tube the tube data set has to be loaded again.

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9.4. Dose rate control

9.4.1. AMPLIMAT sensitivity

- Select *"Dose Rate Control/ AMPLIMAT/* ***Sensitivity****"*.

- Depending on HW programming of jumper EZ150: W4, program sensitivity accordingly:
  high = × 4 = EZ150: W4 in position 1 = Film/screen combinations with a system speed of over 200.
  low = × 1 = EZ150: W4 in position 3 = Film/screen combinations at 200 or less.

9.4.2. Film/screen combinations

5 film/screen combinations can be programmed for each of the 5 measuring chambers:

- Select menu *"Program/ Dose Rate Control/ AMPLIMAT/ Chamber 1...5/* ***Data Set 1...5****"*.
  The number of the chamber corresponds to the specified unit number of the dose measuring unit.

The choice between automatic and manual DRC processing is possible when an authorized hardware key is inserted in the PC.

Automatic is selected as default and must be used for the initial programming.

Access manual DRC processing by pressing the Esc key.
The manual mode is suitable for:

- Copying complete programming to other measuring chambers
- Setting the basic density
- Changing the desk-displayed names of the programmed film-screen combinations
- Creating backups of the DRC programmings

Automatic DRC processing:

- Select the desired data from the files offered for the following programming steps.
  The files are part of the installation software.
  - Select the programming field with the cursor and enter <Return>.
  - Enter the desired file from the list offered.
  - Select the desired data as required.

FILM	File "film.tdl":	Film types according to description of the manufacturer.
	File "film_bl/ _gr/ _uv.tdl":	General classification of the film according to color, sensitivity S and RLF compensation.
SCREEN	File "screen.tdl":	Screen types according to description of the manufacturer.
	File "lumat_lg.tdl":	Screen types according to luminous matter.
CHAMBER	File "chamber.tdl":	Different types of measuring chambers.
CASSETTE	File "cassette.tdl":	Different types of cassettes.
SYSTEM CORRECTION	File "syscor.tdl":	Select "no corr. (ISO 9236-1)".
CORRECTION FACTOR	Default: 1.0	Correction factor for switch-off dose.

Based on the combination of the components entered, the processor calculates the switch-off dose, kV correction and RLF compensation and creates a name for the film/screen combination, e.g. "B400".

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Since the data selected are not directly stored in the generator, it is recommended that they be entered in the following table.

- Reset the generator.

Color and sensitivity class of the film/screen combination are displayed on the desk, for instance, B 400.
The other film/screen combinations (data set 1...5) for the chamber can be selected with the ± buttons.

		Chamber 1	Chamber 2	Chamber 3	Chamber 4	Chamber 5
Data Set 1	Film:	.....	.....	.....	.....	.....
	Screen:	.....	.....	.....	.....	.....
	Chamber:	.....	.....	.....	.....	.....
	Cassette:	.....	.....	.....	.....	.....
	Sys.corr.:	.....	.....	.....	.....	.....
	Corr. factor:	.....	.....	.....	.....	.....
Data Set 2	Film:	.....	.....	.....	.....	.....
	Screen:	.....	.....	.....	.....	.....
	Chamber:	.....	.....	.....	.....	.....
	Cassette:	.....	.....	.....	.....	.....
	Sys.corr.:	.....	.....	.....	.....	.....
	Corr. factor:	.....	.....	.....	.....	.....
Data Set 3	Film:	.....	.....	.....	.....	.....
	Screen:	.....	.....	.....	.....	.....
	Chamber:	.....	.....	.....	.....	.....
	Cassette:	.....	.....	.....	.....	.....
	Sys.corr.:	.....	.....	.....	.....	.....
	Corr. factor:	.....	.....	.....	.....	.....
Data Set 4	Film:	.....	.....	.....	.....	.....
	Screen:	.....	.....	.....	.....	.....
	Chamber:	.....	.....	.....	.....	.....
	Cassette:	.....	.....	.....	.....	.....
	Sys.corr.:	.....	.....	.....	.....	.....
	Corr. factor:	.....	.....	.....	.....	.....
Data Set 5	Film:	.....	.....	.....	.....	.....
	Screen:	.....	.....	.....	.....	.....
	Chamber:	.....	.....	.....	.....	.....
	Cassette:	.....	.....	.....	.....	.....
	Sys.corr.:	.....	.....	.....	.....	.....
	Corr. factor:	.....	.....	.....	.....	.....

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Manual DRC processing:

The current data set of the film/screen combination is displayed.

Abbreviation:	Abbreviation for the film/screen combination. Example: B400 = blue, intensification 400.
Dose Request Chamber:	Parameter of the measuring chamber type in [µGy/V].
Dose of FSC:	Switch-off dose of the film/screen combination in [µGy]. Linear ratio with respect to the film density.
kV70-Char. U_0...9:	Checkpoints for kV-dependent density correction.
kV70-Char. Drel_0...9:	Relative correction value for the dose.
RLF t_0...9:	Checkpoints for time-dependent density correction (RLF).
RLF Drel_0...9:	Relative correction value for the dose.

- If required, change the data.
  Usually no value except the basic density "Dose of FSC" must be changed (see chapter 13.)
- Transmit the data set with F2.
- Reset the generator.

The SAVE (F3) and LOAD (F4) functions of ***XRGSCOPE*** permit straightforward copying of the measuring chamber programmings.

9.4.3. Fault exposure detection

Fault exposure detection is switched on as a default for AEC and TDC. If in the initial phase of an exposure too little dose is measured, the exposure is aborted to protect the patient.

- Time of control measurement: 10% of backup time, min. 250 ms at TDC
- Dose minimum: 4% of set density voltage at AEC, 4...10% at TDC
- Backup time AEC: Calculated time from 10 times mAs of the respective 2-factor technique. Max. 4s.
- Backup time TDC: Exposure time set 0.3...6 s

This additional precaution can be switched off for both techniques individually in the menu *"Program/ Dose Rate Control/ Fault Exposure Detection/* ***AEC*** *or* ***TDC****"*.

This monitoring does not take effect in the following cases, irrespective of programming:

- Using film/screen combinations with high speed in AEC technique.
- Exposure time in TDC technique is lower than 1 s.

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9.5. Registration devices

- Select menu *"Program/ Registration devices/ RGDV 1...8/* ***Data Set A...B"***.
- Program the data set A and B of RGDV 1.....8 for all exam./aux. units desired.

Data set A:

Room:	Room number of the exam./aux. unit for room decade (radiation warning display and door contact).		
Tube:	Tube assignment for the exam./aux. unit.		
Release circuit number:	Number of the release decade of the release circuit adaptation unit programmed (e.g.: 1 for X1 etc., see Z1-1.2).		
Enable handswitch at release circuit:	No	=	Operation/release via the handswitch at the desk.
	Yes	=	Release via release decade.
Syncmaster present:	No	=	free cassette (without cassette present interlock)
	Yes	=	Bucky or tomo synchronous contact (20/21).
Exposure switch type:	Single step	=	Exposure request instantly with preparation.
	Double step	=	Preparation request plus exposure request.
Bucky format density correction:	Density correction in steps of 6%. Range: –8 ... +8 Valid only when the assigned format contact is opened.		
Cone density correction:	Density correction in steps of 6%. Range: –8 ... +8 Valid only when the assigned cone contact is opened.		
Dose measurement input:	Measuring chamber respectively at input EZX 21,22,31,32,41		
	none	=	No measuring chamber assigned. For free cassette or tomography without TDC.
No break after exposure end:	no	=	Instant braking after exposure.
	yes	=	More than one exposure possible with the same preparation. For tomo recommended.
Release delay:	disable	=	For free cassette and tomography without TDC.
	enable	=	For all automatic techniques.
Mounted radiographical controller:	none	=	No CAN controlled examination unit is assigned to this RGDV.
	Bucky controller 1...2	=	CAN controlled bucky unit 1 or 2 is assigned to this RGDV.
	THORAVISION	=	THORAVISION system is assigned to this RGDV.
Release circuit adaptation unit:	Assignment of the release unit 1WA, 2WA,1WB, 2WB.		
	none	=	free cassette or in case of a CAN driven examination unit
Mounted tomo extension:	none	=	Tomography time input not possible via 1WA or 2WA.
	1WA	=	(1)WAX21 valid as tomography time input.
	2WA	=	2WAX21 valid as tomography time input.

Bucky Controller 1 may only be programmed for RGDV 1...4 and Bucky Controller 2 may only be programmed for RGDV 5...8.

An RGDV must not be assigned a "Mounted radiographical controller" and a "Release circuit adaptation unit" together.

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Data Set B:

Used for tomo:	Yes/No With "Yes" a definition of the tomography time is expected from the examination unit, e.g. via WAX21.
Disable time override:	Yes/No With "Yes" time correction via ± buttons on the desk disabled. Automatically disabled with "Used for tomo = Yes".
Tube power factor:	1 ... 100%
kV steps:	Single = kV-grading in steps of 1 kV. Dose equivalent = kV-grading corresponding to 20% density change.
mAs steps:	step width in 25, 12 or 6%.
mA steps:	step width in 25, 12 or 6%.
time steps:	exposure time step width in 25, 12 or 6%.
Density steps:	step width in 25, 12 or 6%.
Density correction (6% steps):	–8 ... 0 ... +8 correction steps. For correction see chapter 13.
Underexposure display (non-automatic techniques):	Yes = Underexposure is also indicated with techniques without AMPLIMAT. No = e.g. tomo
Tube overload protection:	On = Overload protection active (default): red = exposure not possible Off = Exposures are possible irrespective of load status.

desk display	tube load
green	100 %
green – yellow	100 %
yellow	80 %
yellow – red	64 %
red	0 %

- Select menu *"Program/ Registration Devices/ RGDV Interface Assignment/* ***Bucky/Tomo 1WA...2WA***".
  There must be no programming here if the diagnostic unit is connected up via the CAN interface.
- Assign the format and ready contacts of the decade connector WAX11 or WAX12 to a bucky or tomography RGDV. Refer to Z1-15.1.
  - Decade Bucky 1 (X11) — See following table.
  - Decade Bucky 2 (X12) — Program the functions as for the first Bucky decade.
    But both the tomo mode switch and the tomo RGDV may not be activated twice.
  - Tomo Time — 0.1 ... 6000 ms for each trajectory.

One tomography unit can be programmed for each device interface.

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Decade Bucky 1 ... 2

Tomo mode switch:	disable =	Input "tomo mode" is not activated. Changeover Bucky/tomography not possible via the examination unit.
	enable =	Input "tomo mode" is activated. Remote changeover Bucky/tomography possible. Bucky and tomo RGDV must be defined.
Bucky RGDV – switch related:	none/ RGDV 1...8	
	The inputs "format contacts" and "bucky ready" are activated.	
	When the tomo mode switch is enabled, this RGDV is activated when the tomo mode switch is open.	
Bucky RGDV:	none/RGDV 1...8	
	The inputs "format contacts" and "bucky ready" can be assigned to another RGDV button.	
Tomo RGDV – switch related:	none/ RGDV 1...8	
	The inputs "format contacts" and "tomo ready" are activated. When the tomo mode switch is enabled, this RGDV is activated when the tomo mode switch is closed.	

- Reset the generator.

9.6. Example for RGDV programming

9.6.1. Unit connected via adapter WA

Examination unit:

- HDH without / with tomo time input (unit UP)
- Tomo programs: 1= 30°, 0.8 s (UP 6/7:01)
  2= 30°, 3.2 s (UP 6/7:02)
  3= 8°, 0.8 s (UP 6/7:03)
  4= 8°, 3.2 s (UP 6/7:04)
- Connection via Adapter for 4 Aux. Units WA
- Ready and format contacts connected at WAX11.
- 1 tube

RGDV 1 =	Bucky	Release circuit 1 at WAX1, Measuring chamber at EZX21
RGDV 2 =	Tomography	Release circuit 2 at WAX2
RGDV 3 =	Bucky wall stand	Release circuit 3 at WAX3, Measuring chamber at EZX31
RGDV 4 =	Free cassette	– –
	/Free cassette USA	Release circuit 4 at WAX4 for free exposure interlock

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Programmings in ( ) relate to the option "Automatic tomographic time input" via assembly UP of HDH.

Programmings in [ ] relate to the option "Tomo Density Control".

Programmings after a stroke relate to the option "Free Exposure Interlock", which is necessary in some countries such as the USA.

Menu *"Program/ Registration devices/ ...*

RGDV #/ Data Set A	**RGDV1**	**RGDV2**	**RGDV3**	**RGDV4**
– Room:	Room 1	Room 1	Room 1	Room 1
– Tube:	Tube 1	Tube 1	Tube 1	Tube 1
– Release circuit number:	Circuit 1	Circuit 2	Circuit 3	Circuit 4
– Enable handswitch at release circuit:	No	No	No	No
– Syncmaster present:	Yes	Yes	Yes	No / Yes
– Exposure switch type:	Double Step	Double Step	Double Step	Double Step
– Bucky format density correction:	0	0	0	0
– Cone density correction:	0	0	0	0
– Dose measurement input:	EZ X21	none [EZ X21]	EZ X31	none
– No break after exposure end:	no	yes	no	no
– Release delay:	enable	disable [enable]	enable	disable
– Mounted radiographical controller:	none	none	none	none
– Release circuit adaptation unit:	1WA	1WA	1WA	none / 1WA
– Mounted tomo extension:	none	none(1WA)	none	none
RGDV #/ Data Set B				
– Used for tomo:	No	No (Yes)	No	No
– Disable time override:	No	No	No	No
– Tube power factor:	100 %	100 %	100 %	100 %
– kV steps:	Dose equivalent	Dose equivalent	Dose equivalent	Dose equivalent
– mAs steps:	25%	25%	25%	25%
– mA steps:	25%	25%	25%	25%
– time steps:	25%	25%	25%	25%
– Density steps:	12%	12%	12%	12%
– Density correction (6% steps):	0	0	0	0
– Underexposure display ...:	Yes	No	Yes	Yes
– Tube overload protection:	On	On	On	On

Menu *"Program/ Registration devices/ RGDV Interface Assignment/ ...*

***Bucky/Tomo 1WA/ Decade Bucky 1* (WAX11)**

– Tomo mode switch:	disable (enable)	(activates input at WAX11:3)
– Bucky RGDV – switch related:	RGDV 1	activates inputs at WAX11:1 and 10 for RGDV 1
– Bucky RGDV:	RGDV 3	activates inputs at WAX11:1 and 10 for RGDV 3
– Bucky RGDV:	none	
– Tomo RGDV – switch related:	RGDV 2	activates inputs at WAX11:1 and 5 for RGDV 2

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Bucky/Tomo 1WA/ Decade Bucky 2 **(WAX12)**

- Tomo mode switch: disable
- Bucky RGDV – switch related: none
- Bucky RGDV: none
- Bucky RGDV: none
- Tomo RGDV – switch related: none

Bucky/Tomo 1WA/ Tomo time

– Tomo time 1:	800 ms	time setting for input at WAX21:1
– Tomo time 2:	3200 ms	time setting for input at WAX21:2
– Tomo time 3:	800 ms	time setting for input at WAX21:3
– Tomo time 4:	3200 ms	time setting for input at WAX21:4
– Tomo time 5 ... 8:	0.1 ms	any valid value for inputs WAX21:5...8

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9.6.2. Unit connected via CAN interface

Examination unit:
- Bucky DIAGNOST TH with wall stand VE or VT
- with sensing and/or tomography (= with Bucky controller)
- 1 tube

RGDV 1 = Bucky — Measuring chamber at EZX21
RGDV 2 = Tomography
RGDV 3 = Bucky wall stand — Measuring chamber at EZX31
RGDV 4 = Free cassette

Programmings in [ ] relate to the option "Tomo Density Control".

Menu *"Program/ Registration devices/ ...*

RGDV #/ Data Set A	**RGDV1**	**RGDV2**	**RGDV3**	**RGDV4**
– Room:	Room 1	Room 1	Room 1	Room 1
– Tube:	Tube 1	Tube 1	Tube 1	Tube 1
– Release circuit number:		does not matter		
– Enable handswitch at release circuit:	No	No	No	No
– Syncmaster present:	Yes	Yes	Yes	No
– Exposure switch type:	Double step	Double step	Double step	Double step
– Bucky format density correction:	0	0	0	0
– Cone density correction:	0	0	0	0
– Dose measurement input:	EZ X21	none [EZ X21]	EZ X31	none
– No break after exposure end:	no	yes	no	no
– Release delay:	enable	disable [enable]	enable	disable
– Mounted radiographical controller:	Bucky contr. 1	Bucky contr. 1	Bucky contr. 1	Bucky contr. 1
– Release circuit adaptation unit:	none	none	none	none
– Mounted tomo extension:	none	none	none	none

RGDV #/ Data Set B	**RGDV1**	**RGDV2**	**RGDV3**	**RGDV4**
– Used for tomo:	No	Yes	No	No
– Disable time override:	No	No	No	No
– Tube power factor:	100 %	100 %	100 %	100 %
– kV steps:	Dose equivalent	Dose equivalent	Dose equivalent	Dose equivalent
– mAs steps:	25%	25%	25%	25%
– mA steps:	25%	25%	25%	25%
– time steps:	25%	25%	25%	25%
– Density steps:	12%	12%	12%	12%
– Density correction (6% steps):	0	0	0	0
– Underexposure display ...:	Yes	No	Yes	Yes
– Tube overload protection:	On	On	On	On

Menu *"Program/ Registration devices/ RGDV Interface Assignment/ Bucky/Tomo 1WA...2WA/ Decade Bucky 1 ... 2*

- Tomo mode switch: disable
- Bucky RGDV – switch related: none
- Bucky RGDV: none
- Tomo RGDV – switch related: none

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10. Tube adjustment



Warning!
Radiation is released during the adjustment procedure!

The generator must be in the READY state, i.e. the green ring at the desk must be illuminated!

10.1. Tube conditioning

This procedure must be performed for each new tube to be connected up, irrespective of the storage time. The interval times between exposures must be adhered to and monitored with a watch. For tubes with a maximum of 125 kV the last two break-in stages must be at 109 kV and 125 kV. The break-in of the tube only takes place using the large focus.

- Perform the following programmings temporarily:
  - In the menu *"Program/ Tubes/* ***Tube Operating Modes****":*

    Intermediate boost: Disable
    Rotation prolongation after prep: Disable
  - For each tube connected in one of the assigned RGDVs (free cassette recommended) in the menu *"Program/ Registration devices/ RGDV #/****Data Set A****":*

    Enable handswitch ...: No
    Syncmaster present: No
    Exposure switch type: Double Step
    Dose measurement input: none
    No break after exposure end: **yes**
    Release delay: disable
    Mounted radiographical controller: none
    Release circuit adaptation unit: none
- Reset generator.
- Select appropriately programmed auxiliary for the respective tube to be break in.
- Select large focus.
- Release exposures according to the following table.

  The exposure run must always be made at one kV level without any repeated start-up of the tube, i.e. the PREP button must always remain pressed during the run.

Number of EXPs	kV	mAs	Pause [s]
5	81	125	1
			30
3	102	125	1
			30
2	117 (109)	125	1
			60
2	141 (125)	125	1
			120

  In the event of electrical interference the process must be continued after an interval of 5 minutes, commencing at the lower kV level.
- Bring generator programming to the original status.
- Reset generator.

After operating intervals at the customer's of over 3 months it is recommended that 5 exposures be made on the large focus at 81 kV and 125 mAs. Between exposures there should be intervals of 15 s.

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10.2. Adaptation of the tube

Adaptation is an automatic process which has to be performed for each focus of all the tubes connected.

Boost Adaptation, where the inertia of the filament with respect to heating up and cooling down is registered, is integrated into this process.

In case an error message occurs during the adaptation procedure, reset the generator and repeat the adaptation for this particular focus.

- Check whether the upper kV limit for data adaptation in the menu *"Program/ Tubes/* ***Tube Limits"*** is programmed according to the tube connected.

  If older tubes are to be operated on this generator, it is urgently recommended that the maximum kV used in practical operation so far be specified instead of the theoretical possible value.

- Select menu *"Adjust/* ***Tube Adaptation"***.

- Select the tube to be adapted and the focus to be adapted.
  Start with the small focus!

- Press button F2.
  - "Adap" is displayed on the desk.
  - "Waiting" is displayed on the screen.

- Wait until the generator is in the READY state.

- Start the adaptation procedure by pressing the handswitch continuously.

  The generator carries out adaptation of the focus automatically. It may happen that the red LED on the desk lights up for a short time.

  The tube adaptation of the focus is complete when "Adap" has disappeared on the desk and "Test" is displayed.

- Let go of the handswitch.

- Reset the generator.

- Repeat the adaptation procedure for each additional focus and tube.

  Do not try to adapt VARIOFOCUS as middle focus.
  VARIOFOCUS is a combination of both small and large focus.

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11. Application Limits

Using the menu *"Program/ Application Limits/* ***X-Mode Limits****"* all the types of generator technique available can be varied in the following parameters:

- Min./Max. Time Limit
- Min./Max. Current Time Product Limit

A modification is usually only necessary if specific national legislation defines different limits.

The kV-dependent mAs limits can be accessed via the menu *"Program/ Application Limits/* ***Thoravision Limits****"*. They are activated only in conjunction with an on-line THORAVISION unit.
A change may only be made if instructed to do so by the service centre.

Reference files on floppy disk: – ref_limx.tdl X-ray limits
– ref_limt.tdl THORAVISION limits

12. Programming the operating desk

A maximum of up to 1024 APRs can be stored in the generator.

On a single RGDV button either up to 80 APRs can be programmed directly (10 pages of 8 each) or up to 250 APRs via menus.

The initial data sets are called ### APR name ### and they have the same exposure parameters.

They can be directly assigned or via menu and submenu levels to registration devices RGDV 1...8.

In case "Test APR" is displayed after selection of a registration device, at least this particular registration device has not been assigned to any APRs.

12.1. Language

The language for operating instructions is selected in this menu.

- Select menu *"Program/ Human interface/* ***Select Language****"*.
- Select the desired language:
  - English
  - German
  - French
  - Spanish
- Reset the generator.

The following table lists which characters can be displayed on the control desk and how they can be indicated/entered at the service PC, e.g. for APR names.

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Certain characters can be generated at the PC only via the decimal code. To do so, press the "Alt" key on the PC and enter the numerical code.

Character display on the control desk				Possible PC display (code 850)	Input at the PC
English	German	French	Spanish		
!	!	!	!	!	
#	#	£	£	#	
$	$	$	$	$	
%	%	%	%	%	
&	&	&	&	&	
'	'	'	'	'	
(	(	(	(	(	
)	)	)	)	)	
*	*	*	*	*	
+	+	+	+	+	
,	,	,	,	,	
–	–	–	–	–	
.	.	.	.	.	
/	/	/	/	/	
0	0	0	0	0	
1	1	1	1	1	
2	2	2	2	2	
3	3	3	3	3	
4	4	4	4	4	
5	5	5	5	5	
6	6	6	6	6	
7	7	7	7	7	
8	8	8	8	8	
9	9	9	9	9	
:	:	:	:	:	
;	;	;	;	;	
<	<	<	<	<	
=	=	=	=	=	
>	>	>	>	>	
?	?	?	?	?	
@	§	à	§	@	
A	A	A	A	A	
B	B	B	B	B	
C	C	C	C	C	
D	D	D	D	D	
E	E	E	E	E	
F	F	F	F	F	
G	G	G	G	G	
H	H	H	H	H	
I	I	I	I	I	
J	J	J	J	J	
K	K	K	K	K	

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Character display on the control desk				Possible PC display (code 850)	Input at the PC
English	German	French	Spanish		
L	L	L	L	L	
M	M	M	M	M	
N	N	N	N	N	
O	O	O	O	O	
P	P	P	P	P	
Q	Q	Q	Q	Q	
R	R	R	R	R	
S	S	S	S	S	
T	T	T	T	T	
U	U	U	U	U	
V	V	V	V	V	
W	W	W	W	W	
X	X	X	X	X	
Y	Y	Y	Y	Y	
Z	Z	Z	Z	Z	
[	Ä	.	¡	[	
\	Ö	ç	Ñ	\	
]	Ü	§	¿	]	
^	^	^	^	^	
_	_	_	_	_	
'	'	'	'	'	
a	a	a	a	a	
b	b	b	b	b	
c	c	c	c	c	
d	d	d	d	d	
e	e	e	e	e	
f	f	f	f	f	
g	g	g	g	g	
h	h	h	h	h	
i	i	i	i	i	
j	j	j	j	j	
k	k	k	k	k	
l	l	l	l	l	
m	m	m	m	m	
n	n	n	n	n	
o	o	o	o	o	
p	p	p	p	p	
q	q	q	q	q	
r	r	r	r	r	
s	s	s	s	s	
t	t	t	t	t	
u	u	u	u	u	
v	v	v	v	v	
w	w	w	w	w	
x	x	x	x	x	

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Character display on the control desk				Possible PC display (code 850)	Input at the PC
English	German	French	Spanish		
y	y	y	y	y	
z	z	z	z	z	
{	ä	é	▪	{	Alt +123
¦	ö	ù	ñ	¦	Alt +124
}	ü	é	Ç	}	Alt +125
~	ß	–	~	~	Alt +126
				Δ	Alt +127
◢	◢	◢	◢	á	Alt +160
■	■	■	■	í	Alt +161
⊢	⊢	⊢	⊢	ó	Alt +162
£	£	£	£	ú	Alt +163
▪	▪	▪	▪	ñ	Alt +164
§	§	§	§	º	Alt +167
ⅢⅢ	ⅢⅢ	ⅢⅢ	ⅢⅢ	¿	Alt +168
‖	‖	‖	‖	®	Alt +169
≣	≣	≣	≣	¬	Alt +170
≡	≡	≡	≡	½	Alt +171
					Alt +172
					Alt +173
					Alt +174
					Alt +175
°	°	°	°	▒	Alt +176
±	±	±	±	▒	Alt +177
2	2	2	2	■	Alt +178
À	À	À	À	└	Alt +192
Á	Á	Á	Á	⊥	Alt +193
Â	Â	Â	Â	┬	Alt +194
Ã	Ã	Ã	Ã	├	Alt +195
Ä	Ä	Ä	Ä	─	Alt +196
Å	Å	Å	Å	┼	Alt +197
Æ	Æ	Æ	Æ	ã	Alt +198
Ç	Ç	Ç	Ç	Ã	Alt +199
È	È	È	È	╚	Alt +200
É	É	É	É	╔	Alt +201
Ê	Ê	Ê	Ê	╩	Alt +202
Ë	Ë	Ë	Ë	╦	Alt +203
Ì	Ì	Ì	Ì	╠	Alt +204
Í	Í	Í	Í	═	Alt +205
Î	Î	Î	Î	╬	Alt +206
Ï	Ï	Ï	Ï	¤	Alt +207
				δ	Alt +208
Ñ	Ñ	Ñ	Ñ	Đ	Alt +209
Ò	Ò	Ò	Ò	Ê	Alt +210
Ó	Ó	Ó	Ó	Ë	Alt +211
Ô	Ô	Ô	Ô	È	Alt +212

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Character display on the control desk				Possible PC display (code 850)	Input at the PC
English	German	French	Spanish		
Õ	Õ	Õ	Õ	ı	Alt +213
Ö	Ö	Ö	Ö	˘	Alt +214
				˚	Alt +215
Ø	Ø	Ø	Ø	¸	Alt +216
Ù	Ù	Ù	Ù	˝	Alt +217
Ú	Ú	Ú	Ú	˛	Alt +218
Û	Û	Û	Û	ˇ	Alt +219
Ü	Ü	Ü	Ü		Alt +220
Ý	Ý	Ý	Ý	¦	Alt +221
				Ì	Alt +222
ß	ß	ß	ß		Alt +223
à	à	à	à	Ó	Alt +224
á	á	á	á	ß	Alt +225
â	â	â	â	Ô	Alt +226
ã	ã	ã	ã	Ò	Alt +227
ä	ä	ä	ä	õ	Alt +228
å	å	å	å	Õ	Alt +229
æ	æ	æ	æ	µ	Alt +230
ç	ç	ç	ç	Þ	Alt +231
è	è	è	è	þ	Alt +232
é	é	é	é	Ú	Alt +233
ê	ê	ê	ê	Û	Alt +234
ë	ë	ë	ë	Ù	Alt +235
ì	ì	ì	ì	ý	Alt +236
í	í	í	í	Ý	Alt +237
î	î	î	î	¯	Alt +238
ï	ï	ï	ï	´	Alt +239
				˙	Alt +240
ñ	ñ	ñ	ñ	±	Alt +241
ò	ò	ò	ò	˝	Alt +242
ó	ó	ó	ó	¾	Alt +243
ô	ô	ô	ô	¶	Alt +244
õ	õ	õ	õ	§	Alt +245
ö	ö	ö	ö	÷	Alt +246
				¸	Alt +247
ø	ø	ø	ø	°	Alt +248
ù	ù	ù	ù	¨	Alt +249
ú	ú	ú	ú	·	Alt +250
û	û	û	û	¹	Alt +251
ü	ü	ü	ü	³	Alt +252
ý	ý	ý	ý	²	Alt +253
				˙	Alt +254
					Alt +255

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12.2. Automatic programming of APRs

The installation disk contains data files for a complete, typical APR programming in different languages.

Standard APR programs for each application can easily and quickly be loaded for each registration device.

Note
During this procedure the CAN interface on EZX43 must be disconnected if present (THORAVISION or Bucky TH with bucky controller).

- Select menu *"Program/ Human interface/ RGDV related assignment/ RGDV 1...8/* ***Predefined assignment****"*.
- Select with TAB and cursor-down key one of the files listed up, e.g. "ar65eng.tdl".

  Meaning:
  a = APR data file
  r = radiography
  65 = version (month/year)
  m = mono focus tube
  p = pediatrics
  v = with VARIOFOCUS settings for RO 1750, SRO 2550, SRO 33 100
  v9 = with VARIOFOCUS settings for SRO 0950
  eng = language; en(g) = English, de(u) = German, es(p) = Spanish, fr(a) = French

- Select one of the applications listed up, e.g. "Bucky", and load the data file.

  Applications:
  - Bucky — bucky
  - Wallstd — bucky at wallstand
  - Free — free cassette
  - Tomo LT/HDH — linear tomography with units HDH, BTS2, BTS4 (group)
  - Tomo LIN — linear tomography with units HDH, BTS2, BTS4 (paging)
  - Tomo BTC — tomography with unit Bucky DIAGNOST TC
  - Tomo BTH — tomography with unit Bucky DIAGNOST TH

  Extension GR = Group; APRs are divided into groups (menu technique),
  Extension PA = Paging; APRs are assigned directly to an application.

- Repeat this procedure for each registration device.
- Reset the generator.

  Now all APR programs which have been loaded are displayed on the desk.

If required:
- Change the name and the contents of the APRs according to 12.4.
- Change the menus and the assignment of the APRs according to 12.3.

Note
In case a complete APR program setting is to be replaced by another program setting, all other APR program settings under the registration device concerned must be deleted first.

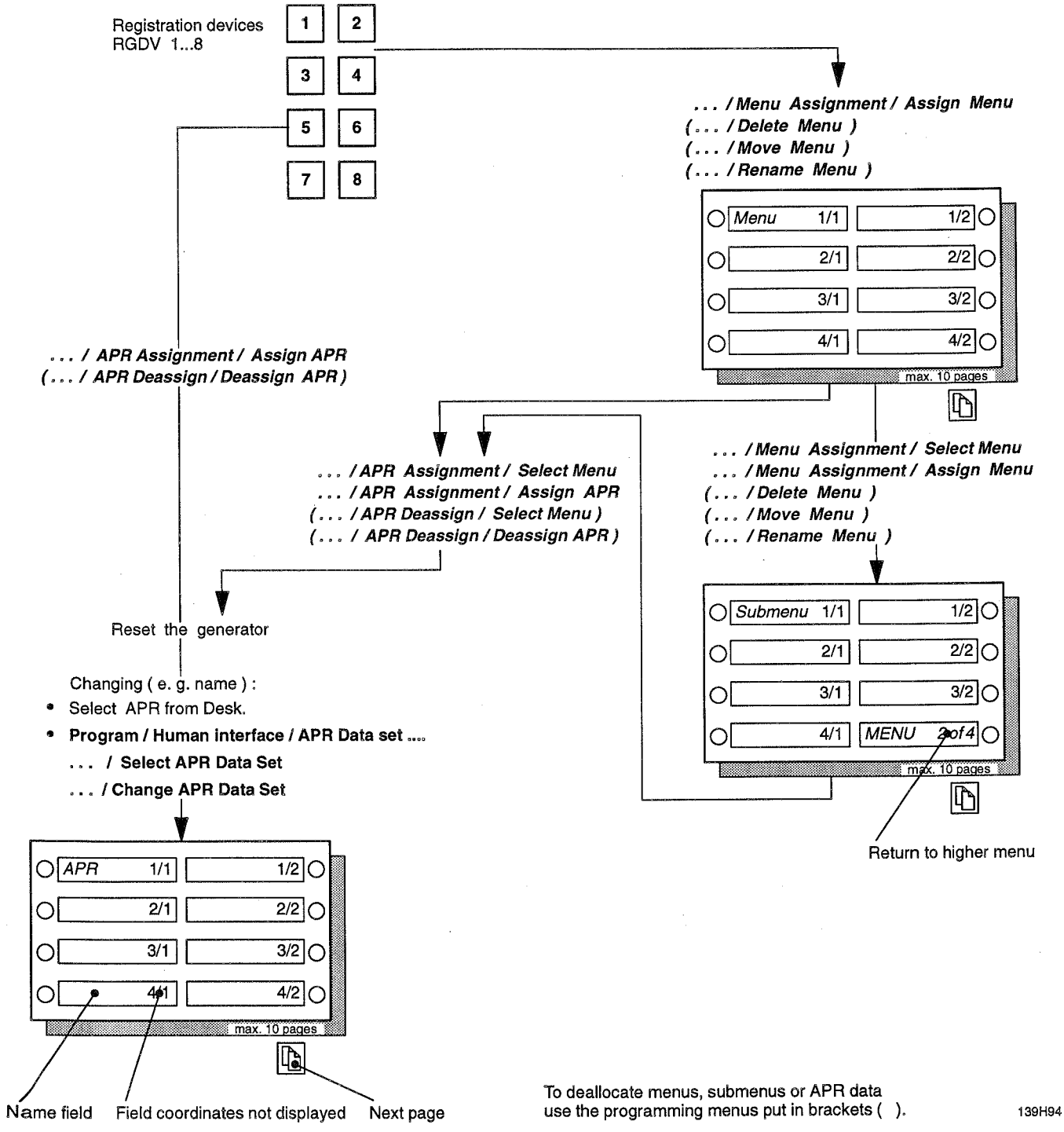
For deleting a program setting call menu "Program/Human interface/RGDV related assignment/RGDV 1...8/Manual assignment/ ***Delete menu****" and select the blank line.*

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12.3. Manual programming of APRs

Manual APR and menu assignment possibilities

- Select service menu ***Program/ Human interface/ RGDV Related Assignment/ RGDV 1...8 /Manual Assignment ...***



To deallocate menus, submenus or APR data use the programming menus put in brackets ( ).

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12.3.1. Creating menus

- Select menu *"Program/ Human interface/ RGDV related assignment/ RGDV 1...8/ Manual assignment/ Menu assignment/* ***Assign menu***".
- Enter the first menu name, e.g. "Body region 1".
- If required, change the location suggested in the display. Otherwise the next vacant location is assigned.
- Enter the second menu name, e.g. "Body region 2".

Etc.

12.3.2. Creating sub menus

- Select menu *"Program/ Human interface/ RGDV related assignment/ RGDV 1...8/ Manual assignment/ Menu assignment/* ***Select menu***".
- Select with the cursor from one of the windows a menu to be assigned with submenus.
- Select menu *"Program/ Human interface/ RGDV related assignment/ RGDV 1...8/ Manual assignment/ Menu assignment/* ***Assign menu***".
- Enter the first submenu name, e.g. "Left side".
- If required, change the location suggested in the display. Otherwise the next vacant location is assigned.
- Enter the second submenu name, e.g. "Right side".

Etc.

12.3.3. Creating or assigning APRs

- Select menu *"Program/ Human interface/ RGDV related assignment/ RGDV 1...8/ Manual assignment/ APR assignment/* ***Select menu***".
- Select with the cursor from one of the windows a menu or submenu.
  If no menu layer is desired, proceed to assign APR.
- Select menu *"Program/ Human interface/ RGDV related assignment/ RGDV 1...8/ Manual assignment/ APR assignment/* ***Assign APR***".
- Select from one of the windows an initial APR or an APR which has not been assigned.
  Initial APR: "### APR name ###
  Not assigned APR: e.g. "Thorax ap"
- If required, change the location suggested in the display. Otherwise the next vacant location is assigned.
- Assign the next APR.

Etc.

- Reset the generator.

Only after a reset of the generator the menus, submenus and APRs are displayed on the desk.

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12.4. Changing of APRs

- Select the APR to be changed on the desk, e.g. ### APR name ###.
- Select menu *"Program/ Human interface/ APR data set/* ***Select APR data set***".
  The number of the APR selected on the desk is displayed. Transmit data with <F2>.
- Select menu *"Program/ Human interface/ APR data set/* ***Change APR data set***".
- Change the contents of the APR, e.g. name, kV etc.
  It is recommended that you select the kV value according to the dose-equivalent series:
  40–41–42–44–46–48–50– 52–55–57–60–63–66–70–73–77–81–85–90–96–102–109–117–125–133–141–150 kV.

APR number:		1 ... 1024
APR name:		up to 16 characters
Focus:	*	small/ middle / vario/ large
Vario focus ratio [%]:		20%, 35%, 50%, 65%, 80% of small focus
Dose measurement field (left)	*	on/ off
Dose measurement field (middle)	*	on/ off
Dose measurement field (right)	*	on/ off
Preferred technique:		Non automatic/automatic
AEC technique:		AEC falling load kV/ AEC fixed current kV-mA/ TDC (Tomo Density Control)
No AEC technique:		kV-mA-ms/ kV-mAs/ kV-mAs-ms
Tube current max. factor [%]:		1 ... 100
PSC U thin (dose equiv. steps):		0 ... 5
PSC U thick (dose equiv. steps):		0 ... 5
PSC Q thin (6% steps):		0 ... 10
PSC Q thick (6% steps):		0 ... 10
PSC dens. thin (6% steps):		0 ... 10
PSC dens. thick (6% steps):		0 ... 10
Exposure data U [kV]:	*	40 ... 150
Exposure data I [mA]:	*	0.1 ... 2000
Exposure data Q [mAs]:	*	0.001 ... 1000
Exposure time [ms]:	*	1 ... 16000 (60000)
Exposure data density (6% steps):	*	–16 ... +16
Film screen comb.:	*	RGDV-dependent; Default = Data Set 1
Tomo No.:		1 ... 16 assignment of a tomographic figure
Spectral Filter:		none/ 2mm Al/ 0.1mm Cu + 1mm Al / 0.2mm Cu + 1mm Al; Default = none

* = The basic setting of this data can also be performed from the desk ("Reset" + APR). Refer to the operator's manual.

AEC = Automatic Exposure Control

The following parameters must also be taken into account for AEC techniques:

- mAs: basis for calculating the backup time for AEC, the tube current for AEC fixed current (kV–mA) and the initial mA value for TDC
- t: exposure time for TDC and AEC fixed current

For details see chapters 15 and 16.
If "AEC fixed current kV–mA" or "TDC" is programmed as the preferred technique, the kV–mAs–s– technique must be selected under "No AEC technique".

- Transmit data with <F2>.
- Select the next APR on the desk, select it in the programming menu and change it.

Etc.

- Reset the generator.

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12.5. Moving/copying of an APR data set

Determination of the number of APR data set "x" to where APR data set "y" is to be moved/copied.

- Select APR data set "x" on the desk.
- Select menu *"Program/ Human interface/ APR Data Set/* ***Select APR Data Set"***.
- Note the number of APR data set "x", for instance, 100.

Changing of the number of APR data set "y" to be moved/copied to the number of APR data set "x"

- Select APR data set "y" on the desk.
- Select menu *"Program/ Human interface/ APR Data Set/* ***Select APR Data Set"***.
  Transmit with F2.
- Select menu *"Program/ Human interface/ APR Data Set/* ***Change APR Data Set"***.
- Replace the number of APR data set "y" with the number of APR data set "x" in the input mask, for instance, nnn ⇒ 100.
- Transmit this number with F2 and reset the generator.

APR data set "y" is displayed in place of the old APR data set "x" on the desk.
In case APR data set "y" is merely moved and not copied to the location of APR data set "x", the original APR data set "y" must be deleted at the end of programming.

12.6. Deleting of APRs

- Select menu *"Program/ Human interface/ RGDV related assignment/ RGDV 1...8/ Manual assignment/ APR deassign/* ***Select menu"***.
  Required only when the APR is assigned to a menu or submenu.
- Select the associated menu or submenu from one of the windows.
- Select menu *"Program/ Human interface/ RGDV related assignment/ RGDV 1...8/ Manual assignment/ APR deassign/* ***Deassign APR"***.
- Select the APR to be deleted from one of the windows.
- Reset the generator.

An APR which has been deleted is no longer displayed on the desk but remains stored in the generator. It can be re-activated according to 12.3.3..

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12.7. Manipulating menus

Deleting:

- Select menu *"Program/ Human interface/ RGDV related assignment/ RGDV 1...8/ Manual assignment/* ***Delete menu****"*.
- Select the menu or submenu to be deleted from one of the windows.
  For deleting a complete APR program select the blank line.
- Reset the generator.

Shifting:

- Select menu *"Program/ Human interface/ RGDV related assignment/ RGDV 1...8/ Manual assignment/* ***Move menu****"*.
- Select the menu or submenu from one of the windows.
- Enter the new positions.
- Reset the generator.

Re-naming:

- Select menu *"Program/ Human interface/ RGDV related assignment/ RGDV 1...8/ Manual assignment/* ***Rename menu****"*.
- Select the menu or submenu from one of the windows.
- Enter the name in the lowermost line.
- Reset the generator.

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12.8. External APR assignment

The first APR extension can be assigned with 2 RGDVs and with 6 APRs per RGDV 1...8. It must be connected up to assembly WA or 1WA, adapter for 4 aux. units. The second one can be assigned with 8 APRs per RGDV 1...8 and must be connected up to assembly 2WA.

If only because of the limited scope for labelling it is recommended that a maximum of two assignments be selected per APR extension.

If only one APR extension is to be connected up to 8 APRs and if there is only one WA assembly, the latter assembly must be programmed as 2WA by closing the soldering jumper W1 on its back panel.

- Define assignment of the extended RGDV and APR keys and enter in the tables below:
  - For the first APR extension select two RGDVs.
  - Read out the respective number of the APRs to be assigned.

    To do this select the corresponding APR at the control desk and establish the respective number using the menu *"Program/ Human Interface/ APR Data Set/* ***Select APR Data Set****"*.

    Device Interface 1 – first and second assignment

RGDV ...			RGDV ...
APR 1 ...	APR 2 ...	APR 1 ...	APR 2 ...
APR 3 ...	APR 4 ...	APR 3 ...	APR 4 ...
APR 5 ...	APR 6 ...	APR 5 ...	APR 6 ...

    Device Interface 2

Assignment for RGDV...		Assignment for RGDV...	
APR 1 ...	APR 2 ...	APR 1 ...	APR 2 ...
APR 3 ...	APR 4 ...	APR 3 ...	APR 4 ...
APR 5 ...	APR 6 ...	APR 5 ...	APR 6 ...
APR 7 ...	APR 8 ...	APR 7 ...	APR 8 ...

- In the corresponding menus *"Human Interface/ RGDV related Assignments/ RGDV 1...8/ External APR Assignments/* ***Device Interface 1...2****"* save the numbers determined.

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13. Density correction

13.1. Density correction for AEC technique

Basic density per film/screen combination:

A hardware key is required at the PC for direct access to the switch-off dose.

- Make a sample exposure for each film/screen combination.
  To do so, select APRs with density correction "0".
- Determine density of the sample exposures.
- Select menu *"Program/ Dose rate control/ AMPLIMAT/ Chamber 1...5 /* ***Data set 1...5"***.
- Select manual DRC programming with <Escape>.
- Correct the switch-off dose FSC according to formular below:

$$\text{New switch-off dose} = \frac{\text{Desired density}}{\text{Measured density}} \times \text{Old switch-off dose}$$

- Transmit the data set with F2.
- Repeat the procedure for each ensuing film/screen combination.
- Reset the generator.

The switch-off dose can be set on the PC even without a hardware key.
To do so, call up the automatic DRC programming, repeat all the selections and change the correction factor for switch-off dose accordingly. Each time this programming is called up all the selections must be repeated.

Organ-dependent correction:

- Select the APR to be changed on the desk.
- Select menu *"Program/ Human interface/ APR data set/* ***Select APR data set"***.
  Confirm the APR number displayed with <Transmit>.
- Select menu *"Program/ Human interface/ APR data set/* ***Change APR data set"***.
- Exposure data density: –16 ... +16 = correction in steps of 6%.

  The number of correction steps must be matched to the programmed step length of the desk display.
  Example:
  The desk display has been programmed to the R20 series (=12%) in the menu *"Program/ Registration devices/ RGDV 1...8/ Data Set B/* ***Density steps"***. To be able to display a density correction of +1 for a certain APR two corrections steps (2x6% = 12%) must be programmed under this APR.
- Select the next APR on the desk, select it in the programming menu and change it.

Etc.

- Reset the generator.

Correction for each RGDV 1...8:

This correction is possible but for reasons of clarity it should not be used.

- Select menu *"Program/ Registration Devices/ RGDV 1...8/* ***Data set B"***.
- Density correction: –8 ... +8 = correction in steps of 6%.

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13.2. Density correction for non-AEC techniques

The supplied APR standard sets are based mostly on a film/screen combination with an intensification of 400.
APR for extremities and some other applications are based on a 100 or 200 type system. Depending on the local situation the "mAs" or "s" parameters of all the relevant APRs must be adapted.
Example:
The customer uses a 200 type system. To change from the existing "400" values the relevant APRs must be reprogrammed to double the mAs products or to double the exposure time (400 divided by 200=2).

- Select the relevant APR at the control desk.
- Set the new parameters at the control desk.
- Save the new parameters as default values. To do this press the "Reset" button and the corresponding APR button. The asterisk in the APR name as an indication of overwritten data disappears.

14. Interlock facility for APR modification

Using the menu *"Program/ Human interface/* ***APR modifiable by User"*** it is possible to prevent a customer from being able to store APR modifications as default setting via the control desk.

Default: yes

15. AEC fixed current (kV–mA)

For this exposure technique the APRs must have the following programming:

- Dose measurement field: on (at least 1 field must be set to ON)
- Preferred technique: automatic
- AEC technique: AEC fixed current kV–mA
- No AEC technique: kV–mAs–ms technique (RUQT)
- Exposure data U: = anatomical kV value
- Exposure data Q: = anatomical mAs product based on the screen–film combination used.
- Exposure time t: = anatomical exposure time.

  The mA value is calculated automatically.

In the APR standard files supplied the following APR is programmed to kV–mA technique
(language: German/English/French/Spanish):

- Dens axis F / dens axis F / dens axis F / atlas F

  The APR is marked with "F".

The mAs value is based on a 400–type screen–film combination and must be adapted to the combinations actually used. If, for example, the 200–type combination is used, the mAs value must be doubled.

If the TDC option is installed, the preferable technique for all exposures is the one where the exposure time is the determining factor. TDC is not restricted to tomography applications.

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16. Tomo Density Control TDC (option)

For this exposure technique the APRs must have the following programming:

- Dose measurement field: on (at least 1 field must be set to ON)
- Preferred technique: automatic
- AEC technique: TDC (Tomo Density Control)
- No AEC technique: kV–mAs–ms technique (RUQT)
- Exposure data U: = anatomical kV
- Exposure data Q: = anatomical mAs product based on the screen–film combination used.
- Exposure time t: = anatomical exposure time.

The mAs product is used to calculate the initial current, indicated under Exposure Data I.
In the APR files supplied all the APRs for tomography applications are programmed to TDC. If there is no TDC option installed, the manual technique will be selected as the Preferred Technique automatically.

TDC is not restricted to tomography applications so it can be preferred for all exposures where exposure time is the determining factor.

The respective mAs product is generally based on a 400–type screen–film combination and must be adapted to the combinations actually used. If, for example, a 200–type combination is used, the mAs product must be doubled.

17. VARIOFOCUS (option)

For the VARIOFOCUS option, special APR files have to be loaded. These are designated with a "v" in the file name and contain correspondingly defined APRs.

VARIOFOCUS is programmed as a percentage mix of the small focus with the large focus. The following steps are possible: 20%, 35%, 50%, 65% and 80%. As a rule, the predefined APRs are programmed at 50%.

The percentage mix is not displayed direct on the control desk and can only be estimated indirectly via the small/large focus exposure time.

It is only possible to display and change the percentage mix via XRGSCOPE menu *"Program/ Human interface/ APR Data Set/* ***Change APR Data Set***". However, VARIOFOCUS can be selected via the control desk and can also be stored as default focus for an APR. The percentage mix is then always 50%.

VARIOFOCUS is only possible for tubes with superimposed focal spots.

The following tubes are suitable for the application: SRO 0950, SRO 2550, SRO 33100, RO 1750.

18. Area exposure product calculation (option)

This option operates only in conjunction with a unit and a collimator which are CAN-controlled and supply information about SID, collimation and added filters.

Check and correction: see ADJUSTMENTS section.

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19. Executing the acceptance test

- Execute the acceptance test according to section *"Acceptance"*.
- Observe all applicable national regulations.

For U.S.A.:

Checking H.H.S. requirements

After completition of setting-to-work, the system must be tested for H.H.S. compliance according the P.M.S.I. comprehensive compliance testing workbook (code No. 4535 800 2035.).

20. Saving all configuration data

A hardware key is required of the PC.

To save the configuration data use the "Configuration Backup" disk supplied.

- Save the complete SW programming of the generator using the menu *"Accept/ Backup/* ***CU Complete****"* on the floppy disk.
  - Default file name: cubackup.tdl
  - Recommended file name: s/n of the generator, e.g. 960007.tdl
  - File size: approx. 250 kB
  - Transfer time: approx. 6 min. (Restore: approx. 15 min.)
- Recommendation:

  In addition, save the APR programmings individually for each RGDV using the menu *"Accept/ Backup/ RGDV related Assignments/ RGDV 1...8/* ***APR Assignments****"* on floppy disk.

  File name: apr_bak#.tdl # = RGDV-number

  Note

  In a backup of the APR programmes all the customized assignments of film-screen combinations will be lost. If APR programmes are loaded into the generator using the Restore command, it is always the first film-screen combination which is assigned to a measuring chamber as the default (data set 1 of chamber 1 ... 5).

  To restore the customized APR assignment, it is absolutely essential that you make a note of which other film-screen combinations (data set 2 ... 5 of chamber 1 ... 5) are assigned to which APRs.

  We recommend creating the information on the PC as a simple text file in the following sequence:
  - *RGDV 1 ... 8*
  - *Menu name and, where applicable, submenu name*
  - *APR*
  - *Data Set 2...5 and/or name of the film-screen combination, e.g. G400*

  and storing it on the backup floppy disk.
- Recommendation:

  In addition, save the programmings for film/screen combinations using the menu *"Program/ Dose Rate Control/ AMPLIMAT/ Chamber 1...5/* ***Data Set 1...5****"* (manual processing) and with the SAVE function (F3 key) on floppy disk.

  Recommended file name: drc##.tdl ## = Chamber and Data Set Number
- Provide the floppy disk with the serial number of the generator.
- Keep the floppy disk in the service documentation.

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21. Labels

- Check the labelling according to the respective generator type.

See drawing 2Z-1.

All lables become visible by swiveling out the label bracket simply by hand and without any tool. The bracket is located at the top left corner of the front side of the cabinet, visibly marked by an "i" (for information) and text "Certified Component Lables Here". If you swivel the label bracket 90 degrees to the right the following labels will appear at its bottom side:

- X-Ray Control:
  - type designation
  - serial No.
  - name and address of manufacturer
  - DHHS certification statement (if necessary)
  - date of manufacture
- X-Ray H.V. Generator:
  - type designation
  - serial No.
  - name and address of manufacturer
  - DHHS certification statement (if necessary)
  - date of manufacture
- Technical Data label with UL/CSA classification (if necessary)

22. Final installation work

- Mount the side panels of the generator cabinet.
- Roll the generator cabinet against the wall.
  Take care that all cables inside the wall junction box are routed in a loop without any kinks.
- Block the two front wheels of the cabinet with the locking screws to guarantee that unauthorized persons cannot accidentally touch parts of the generator which might be dangerous.
- If necessary, level the cabinet with the locking screws.
- Mount the front cover of the generator.

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FAULT FINDING
TEXT

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DRAWINGS

Central rack, service aid	3Z–1

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1. Tools

- Service engineer mechanical tool kit
- mAs meter
- Multimeter
- Digital oscilloscope with 2-beam memory
- PC incl. 3.5" FDD, HW-dongle, serial interface cable, free RAM ≥ 590 KB
- Service software "XRG SCOPE" 4512 152 04755 or higher
- Recommended PLCC extraction tool (AMP 822154–1) 2422 487 89772

2. Notes

Caution!
After the generator has been switched off, hazardous voltages are still applied to the d.c. intermediate circuits of the converter, the rotor control and the mA control.

These voltages are usually discharged within 1 minute to values which are no longer dangerous.

3. Strategy

There are 3 categories of errors:

- The generator cannot be switched on at all or only for a short time.

  See ⇒ 5. "Initialization phase of the generator"
  ⇒ 6. "Switch-on not possible"

- The generator can be switched on but no error numbers are displayed on the operating desk.

  For fault finding use the service PC.

  See ⇒ 4. "Connecting the service PC"
  ⇒ 5. "Initialization phase of the generator"
  ⇒ 7. "Error numbers"

- Error messages are displayed on the desk.

  For fault finding use the service PC.

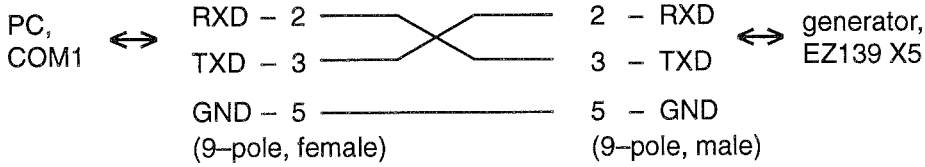
  See ⇒ 4. "Connecting the service PC"
  ⇒ 7. "Error numbers"

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4. Service-PC

4.1. Connection

- Switch the generator on.
- Provide the PC with the HW key and switch it on.
- Connect the PC to X5 on EZ139 CENTRAL UNIT CU via a serial data cable.



4.2. Operation

- Insert the floppy disk with the service program in the PC.
- Call the program with ***xrgscope*** *or with* ***xrgscope lcd*** *for PC's with LCD screen.*
- Enter you password
  The following menu line appears:

File	***OPTIMUS***	***Select Unit***	***Options***	***Help***

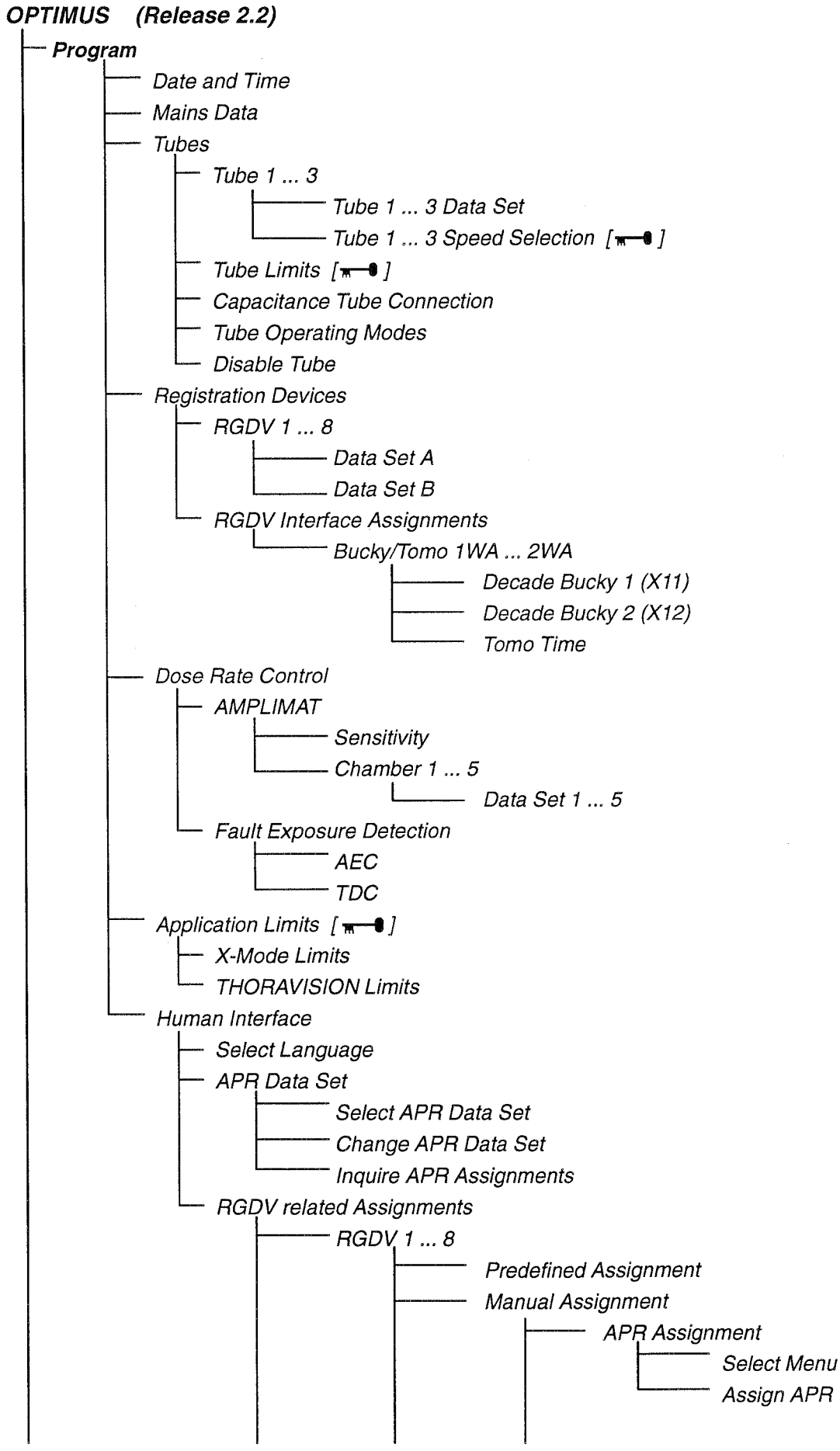
Note

– *Current data files, for instance, for online help, tube types, APR programming are available in BBS.*
Product: Generatoren Hamburg
Download area: OPTIMUS

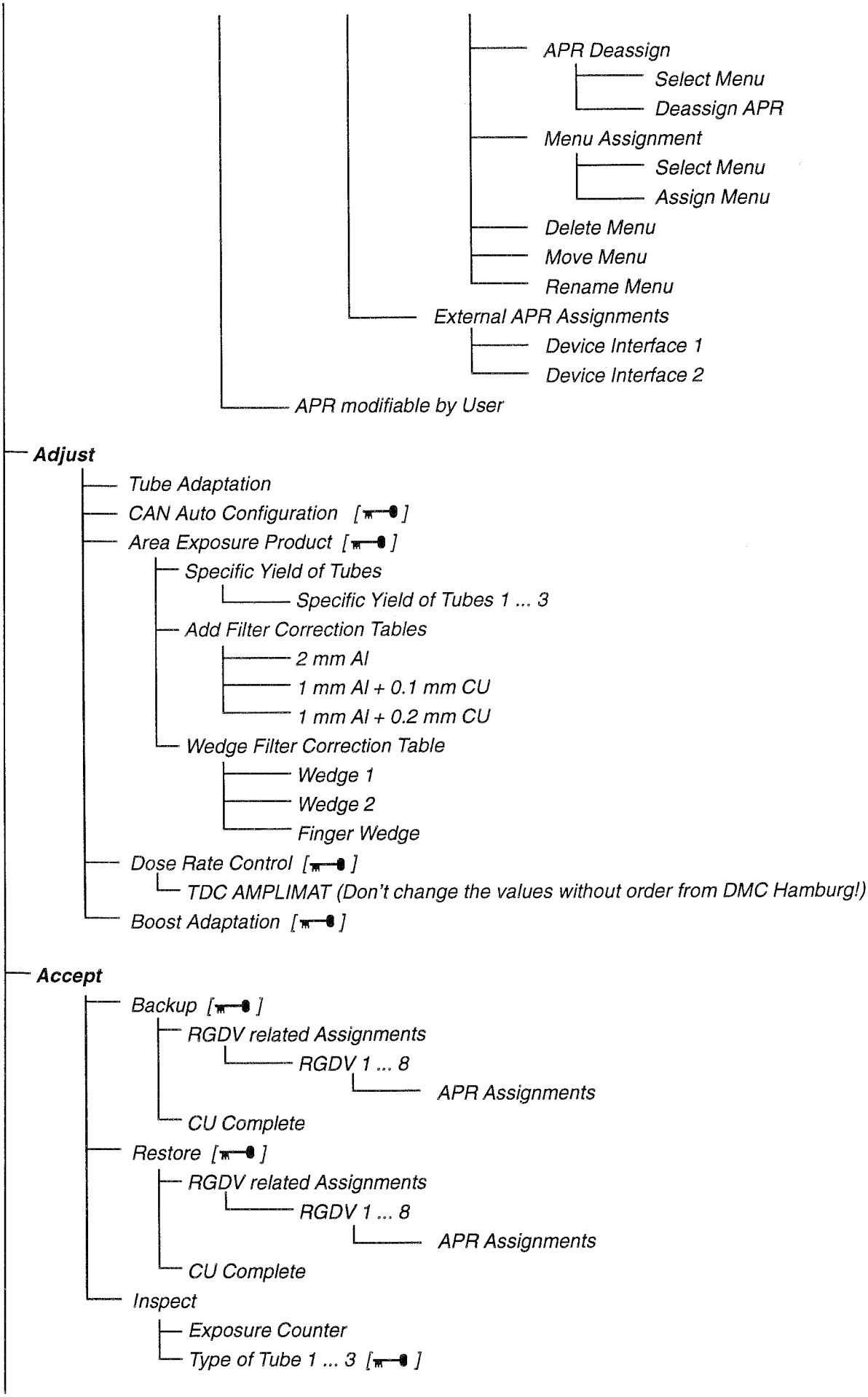
– *If you call the installation program with* ***xrgscope ?*** *the possible starting parameters for the service program will be listed.*

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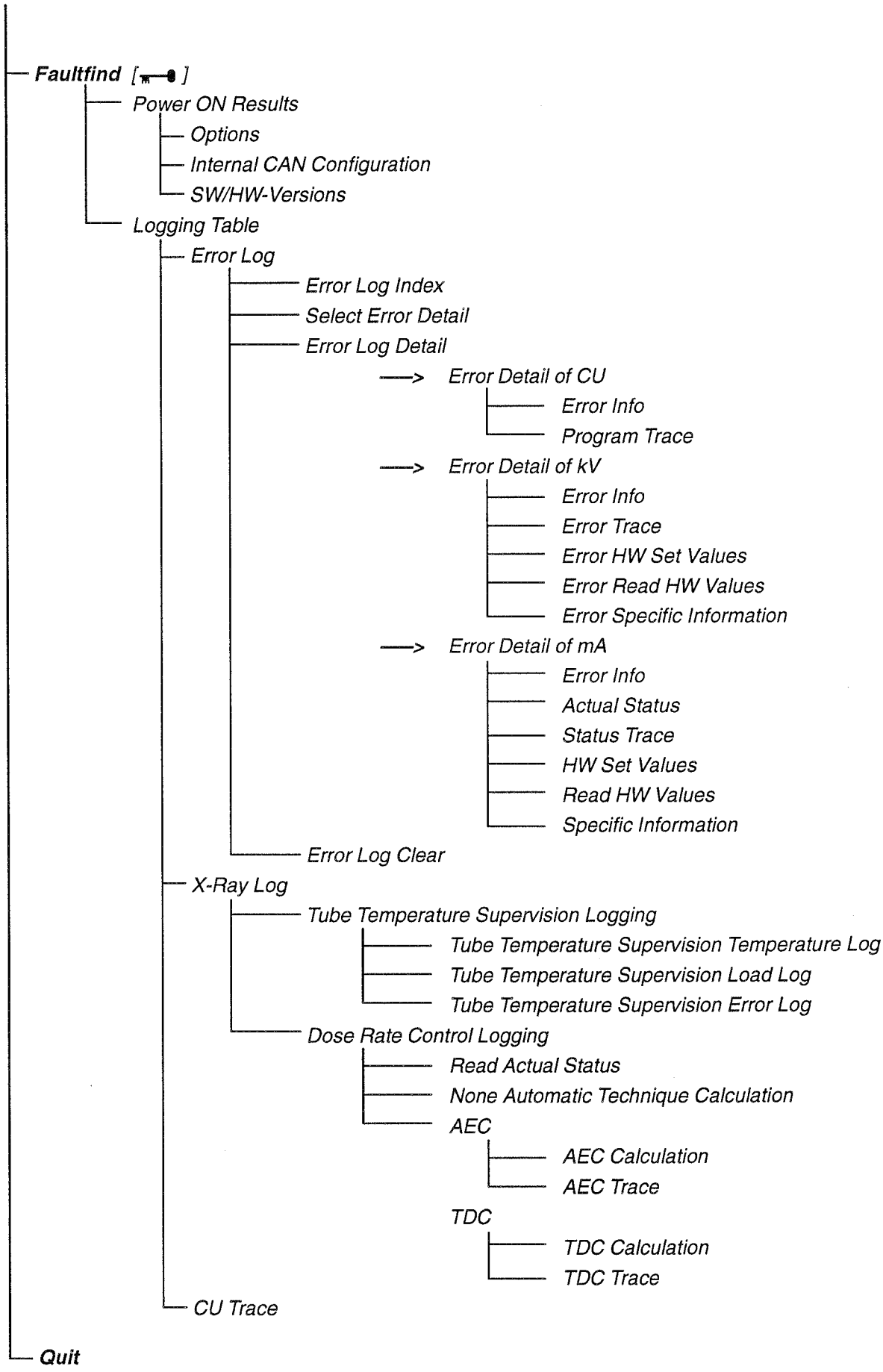
4.3. Menu structure



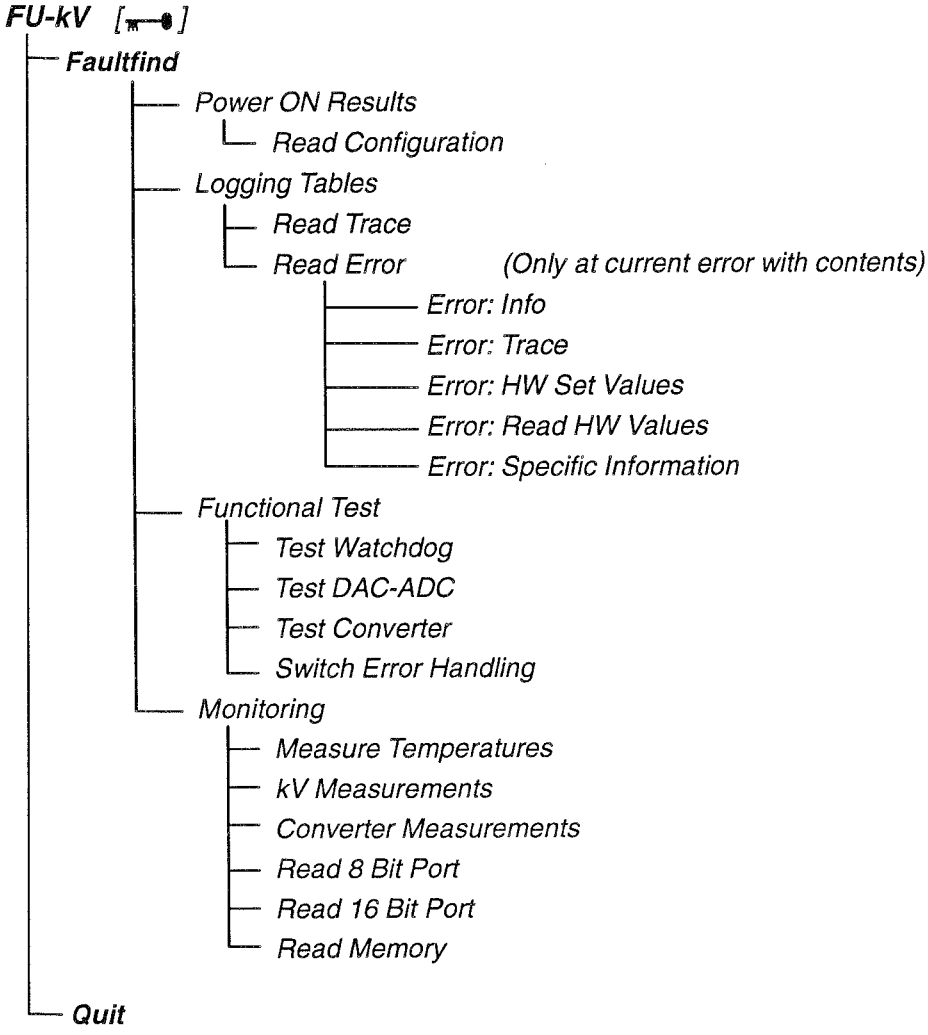
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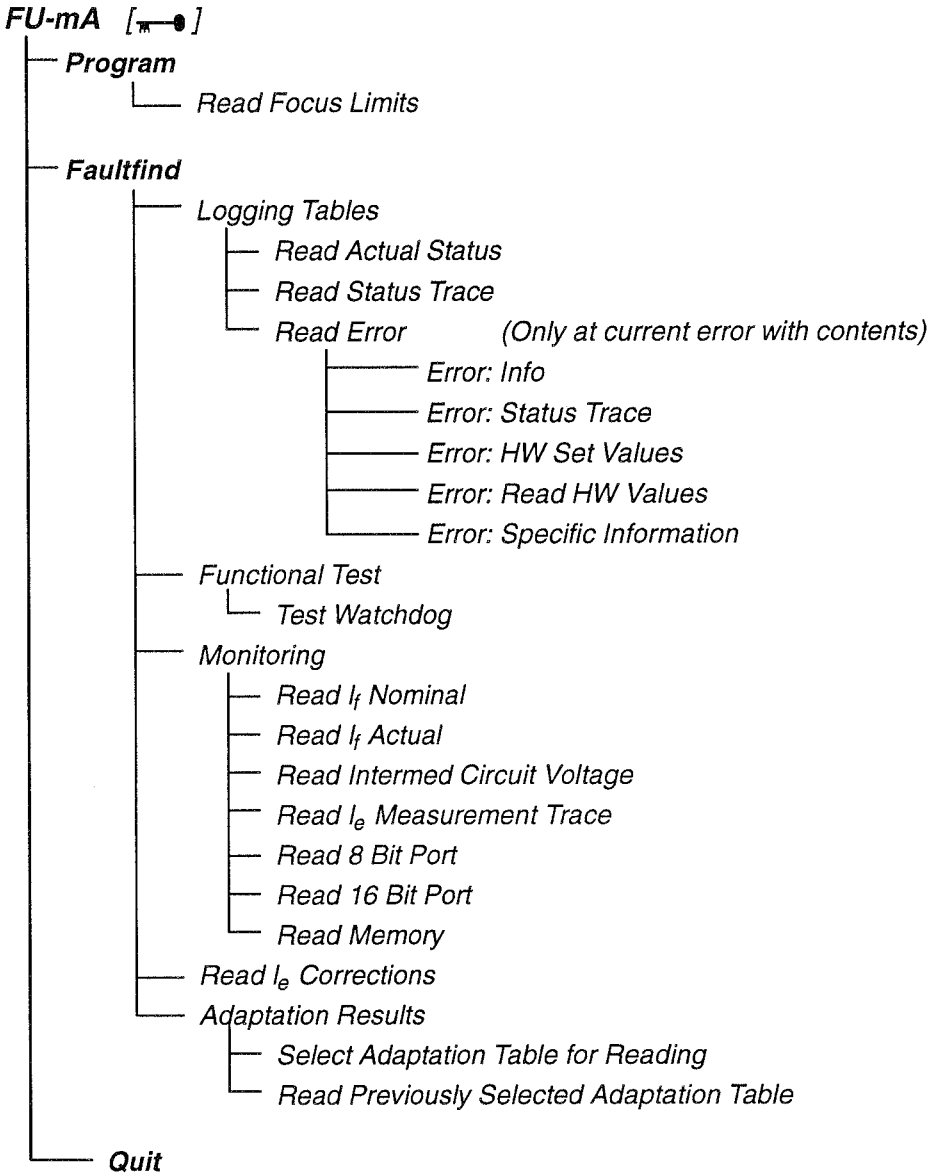
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[🔑] = A hardware key is required

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4.4. Saving data on disk and restoring data

All configurations data and logging tables are stored in battery-buffered CMOS areas.

Therefore, these data should be saved on disk as a backup.

In case data get lost they can easily be restored in the CMOS areas after the error source has been eliminated.

Saving of data:

- Select menu ***"Accept/ Backup/ CU Complete"***.
- Store the data on floppy disk "Generator configuration data" found in the service documentation.
  Default file name: cubackup.tdl
  Recommended file name: s/n of the generator, e.g. 960007.tdl
  File size: approx. 250 kB
  Transfer time: approx. 6 mins.
- Recommendation:
  In addition, save the APR programming individually for each RGDV via the menu ***"Accept/ Backup/ RGDV related Assignments/ RGDV 1...8/ APR Assignment"*** on floppy disk.
  File name: apr_bak#.tdl #= RGDV – number
  Assignment of film/screen combinations to the individual APRs is not saved in this procedure!
- Recommendation:
  In addition, save the programmings for the film/screen combinations via the menu ***"Program/ Dose Rate Control/ AMPLIMAT/ Chamber 1...5/ Data Set 1...5"*** (manual processing) and store them with the SAVE function (F3 key) on floppy disk.
  Recommended file name: drc##.tdl ## = chamber and data set number
  Assignment of film/screen combinations to the individual APRs is not saved in this procedure!

Restoring of data:

Note
During this procedure the CAN interface on EZ X43 must be disconnected if present (THORAVISION or Bucky TH with bucky controller).

- Select menu ***"Accept/ Restore/ CU Complete"***.
- Restore the data from floppy disk.
  Transfer time: approx. 15 mins.
- Reset the generator.
- Program date and time.

Most of the programmings and logging tables can also be stored via the SAVE-function (button F3) of XRG SCOPE.

Some programmings can be restored via the LOAD-function (button F4).

- For service use, only keep the latest version of the backup.
- Never use a complete backup for a different generator.
- APR backups can also be loaded into other generators.
  Since specific kV and mA reductions are also transferred, one should load APR backups only in generators of the same or a lower power class.

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5. Initialization phase of the generator

5.1. Start-up sequence

Switch-on of the generator

|

Pulling-up of ENK 2

|

Selftest of ...

|... control desk C: All display elements are switched on for a short moment.

|... central unit EZ139:

|... kV control EZ130: voltage E is measured in the d.c. intermediate circuit.

|

|... mA control EZ119:

|... basic interface EZ150:

|... rotor control EY:

|... universal I/O EWA/B 102:

| Indicating device: The red status LED of the associated printed-circuit board or assembly is illuminated.

|

|

When the selftests have successfully been completed, the status LED's are blinking.

|

The central unit establishes connection to each functional unit via the CAN bus.

|

| Indicating device: The red status LED of the associated printed-circuit board or assembly grows dark.

|

ENK1 is switched on.

|

The generator is internally ready.

|

The external ready circuits are checked (unit ready, door contact closed, thermal contact of the tube closed, tube not overloaded).

|

The green READY lamp in the operating desk is illuminated.

The generator is in the READY state.

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5.2. Program status displayed on the operating panel

PHILIPS OPTIMUS

- No tube data loaded yet.
- No RGDVs programmed yet.
- No communication between desk and CU.
- Possible error entries:
  00B3, 00B6, 00BA ... F, 00B0, 00BT, 00BX, 00CJ, 00L1, 00PE, 00XB, 00XL, 03FD

70 kV	32.0 mAs	Test

- Tube data loaded.
- Selected focus not adapted.

70 kV	32.0 mAs	Adap

- Status after calling up the adaptation mode.

40 kV	00.0 mAs	Adap

- Start phase of adaptation mode.
  After the Ready signal appears the adaptation can be started up with the release switch.
- Possible error entries after adaptation:
  00BU, 00BV, 00X6

70 kV	320 mAs	100 ms

- Selected focus is adapted.
- AEC/TDC technique:
  For the selected RGDV no measuring unit has been assigned yet.

70 kV	0 ◢	def1

- For the selected RGDV no film/screen combination has been programmed yet.

Test APR		

- No APR data have yet been loaded onto the selected RGDV.

81 kV	0 ◢	B100
skull axial		crâne axial
Schädel ax.		cráneo axial

- Ready status.
  An APR with AEC technique has been selected.

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6. Switch-on not possible

See drawings: Z1–2.1 / 2.2 / 2.3

Z2–2

H1 on PCB EN100 is not illuminated.

Error sources:
- ENF1 was released.
  For fault-finding look in the error buffer.
- ENF1 is not switched on.
- Mains voltage, especially phase L3, is not present.
- ENF2 was released.
  Check: Low-voltage supply
  Filament circuit
  Tube extension
  Rotor control
  External current consumers
- ENF2 is not switched on.
- PCB EN100 or its connections are not okay.

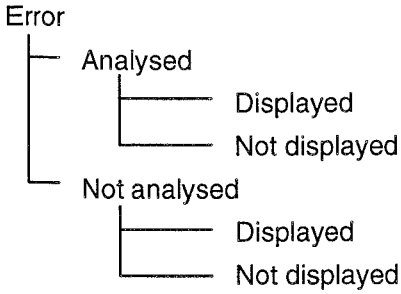
H1 on PCB EN100 is illuminated.

Error sources:
- The EMERGENCY-OFF circuit is open.
- The operating desk is not connected.

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7. Error numbers

7.1. Error classification



Errors are displayed in a code consisting of 4 characters.

Analysed errors:

- These errors are indicated by 4 digits.
- The first two digits indicate the functional unit FU reporting the error.
  00xx = CU-functional unit is concerned
  02xx = kV-functional unit is concerned
  03xx = mA-functional unit is concerned
  etc.
- The last two digits indicate the assembly which is defective.

Not analyzed errors:

- These errors are indicated by 2 digits and 2 letters.
- The first two digits indicate the functional unit reporting the error.
- The last two letters indicate the error symptom.

Displayed errors:

- These errors are indicated on the display of the operating desk for the customer.
- The customer must call the service.
  The customer can inform the service about the respective error number and the service can order the spare parts needed at an early stage of the maintenance procedure.

Not displayed errors:

- These errors are not relevant for the customer.
- In case an error of this category occurs frequently within a certain period of time, a displayed error can be generated.

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7.2. Error list

Sources of error codes indicated in the first two digits (hex):

00=CU	01=FU_DRC	02=FU_kV	03=FU_mA_a	04=FU_mA_b	05=FU_mA_c
06=FU_mA_d	07=FU_CIE	08=FU_HI_a	09=FU_HI_b	0A=FU_RC_a	0B=FU_RC_b
0C=FU_RC_c	0D=FU_ADAP_a	0E=FU_ADAP_b	0F=FU_ADAP_c	10=FU_ADAP_d	11=FU_MDO
12=FU_ANA					

Class: Fatal error, Error, Warning

Error	class	explanation	
00B0		CPU:	Error in application data service interface
00B1		CPU:	IIM was not expected by gen_order_list
00B2		CPU:	HI order is not expected – NO Member in display
00B3		NVRAM:	data language selector is invalid
00B4		CPU:	message invalid in ADopmes
00B5		CPU:	Inputparameter out of range in ADsynta
00B6		NVRAM:	FU adap data for DI are invalid
00B7		CPU:	Message cannot be send
00BA		NVRAM:	data of RGDV are invalid
00BB		NVRAM:	basedata of RGU are invalid
00BC		NVRAM:	statedata of RGU are invalid
00BD		NVRAM:	data of APR are invalid
00BE		NVRAM:	data of active RGU are invalid
00BF		NVRAM:	data of RGKeys are invalid
00BG		APR:	no more lowest level menus available
00BH		APR:	display position collision
00BI		APR:	menu/APR mismatch in same level
00BJ		APR:	menu name not found
00BK		APR:	APR is assigned to a different RGDV
00BL		APR:	menu name already exists
00BM		APR:	max display position reached
00BN		APR:	APR not found in this menu
00BO		NVRAM:	data of menu tree are invalid
00BP		APR is active	
00BQ		CPU:	APR cannot be modified
00BR		CPU:	APR is not assigned to an RGDV
00BS		APR:	The RGDV of the APR is not ready for operation
00BT		NVRAM:	data of APR characteristics are invalid

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Error	class	explanation
00BU		Adaptation paused due to missing load
00BV	CPU:	TTS status message during adaptation
00BW	APR:	APR not accepted by general calculation
00BX	NVRAM:	variofocus allowed invalid
00BY		RGDV order without active RGDV
00CA		CA_err_DPRAM_too_small
00CB	CONF:	Received IIM #1#2H unknown
00CC	CAN:	frame-repeat-counter overflow (IIM #1#2H)
00CD	CAN:	FU #1H not addressable
00CE	CAN:	rx-signal conflict (FU #1H)
00CF	CAN:	no RTR from FU #1H
00CG	CPU:	domain tx response Mailbox type wrong
00CH	CPU:	Invalid tbdor-Parameter FU_type
00CI	CAN:	No FU acknowledges
00CJ		CAN auto configuration successful (#1H)
00CK		CAN auto configuration without success (#1H)
00CL	CAN:	FU #1H not addressable
00CM	CAN:	FU #1H sent event and did not answer RTR
00CQ	SYSCAN:	Radiography system is not responding
00CX	CAN:	last-only-repeat-counter overflow (IIM #1#2H)
00CY	CAN:	abort of rx of IIM #1#2H (unexp frame)
00CZ	CAN:	unexpected frame received after IIM #1#2H
00DA		No CPU-access to CAN-chip
00DB		CAN-chip reset not acknowledged
00DC		CAN-chip reset release not acknowledged
00DD		CAN-chip DPRAM check failed
00DE		unexpected CAN-chip int-pointer
00DF		CAN-chip state undefined
00DG		CAN-chip error-active after passive
00DH		CAN-chip state error-passive
00DI		CAN-chip state bus-off
00DJ		CAN-chip state DPRAM-error
00DK		CAN-chip state DPRAM-error & passive
00DL		unexpected CAN-chip interrupt
00E0		iRMX exception #2#1H occurred

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Error	class	explanation
00Ex		something went wrong
00G0		variable in case statement has undefined value
00G1		condition_code < > OK after CALL to send
00G2		condition_code < > OK after CALL to init
00Hx		something went wrong
00I0		test error
00I1		CPU Index to I/O-table is wrong
00I2		No interrupt reason on sig-bus
00I3		No interrupt reason on XS-bus
00I4		One FU has a WD-error
00Kx		something went wrong
00L1		GC: checksum error
00L2		GC: data access error
00L3		GC: limit data error
00L4		GC: limits inconsistent
00L5		GC: calculation error
00L6		GC: function not implemented
00M0		Unable to initialize FU(s) #1H, #2H, #3H, #4H, #5H, #6H
00M1		Configuration key is missing or defective
00M2		Unable to initialize the FU mA
00M3		No response at all from FU(s) #1H, #2H, #3H, #4H, #5H, #6H
00Mx		ER_error$code$MC
00Ox		error$code$OS_RMX
00PA	W	CPU: IIM/MSC number unknown
00PB	W	CPU: technic mode unknown
00PC	W	CPU: value limit overflow
00PD	E	PC comm: unknown TDL proc ID
00PE	W	NVRAM: DRC NV checksum error
00S?		PC comm: Unexpected error
00SA		PC comm: Not enough space at destination segment
00SB		PC comm: Base out of range
00SC		PC comm: Value too large
00SD		PC comm: Terminator not found
00SE		PC comm: Error in description
00SF		PC comm: Item type unknown

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Error	class	explanation
00SG	PC comm:	Internal type unknown
00SH	PC comm:	Value negative
00SI	PC comm:	Not enough space at destination buffer
00SJ	PC comm:	Syntax wrong
00SK	PC comm:	String too long
00SL	PC comm:	String truncated
00SM	PC comm:	TDL segment overflow
00SN	PC comm:	FU Reference Table full
00SO	PC comm:	Node ID unknown
00SP	PC comm:	FU Code unknown
00SQ	PC comm:	Syntax error in node ID
00SR	PC comm:	No node ID found
00SS	PC comm:	Request not performed
00ST	PC comm:	RMX error
00SU	PC comm:	Enumeration element not found
00SV	PC comm:	Mail corrupted
00SW	PC comm:	Procedure ID unknown
00SX	PC comm:	FU mA incompatible
00SY	PC comm:	FU Off request failed
00SZ	PC comm:	Wrong response
00T?	TTS:	Unexpected Error
00TA	TTS:	Received Message unknown
00TB	TTS:	Tube Supervision Error from FU kV; thermal switch of tube housing okay?
00TC	TTS:	Internal TTS Error
00TD	TTS:	Tube Number unknown
00TE	TTS:	NVRAM Checksum Error
00TF	TTS:	NVRAM unavailable
00Ux	ER_error$code$SC	
00X0	CPU:	wrong timer ID
00X1	CPU:	wrong timer mode
00X2	CPU:	wrong message type
00X3	CPU:	DWORD does not fit into BYTE3
00X4	timeout of X-ray backup timer	
00X5	timeout of X-ray rotation timer	
00X6	timeout setting FUs, response missing	

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Error	class	explanation
00X7		CPU: curve token is NO_TOKEN
00XA		NVRAM: switch table invalid
00XB		NVRAM: tube data rotation invalid
00XC		NVRAM: watch dog invalid
00XD		NVRAM: konfi table invalid
00XE		NVRAM: test data invalid
00XF		NVRAM: RoCo data invalid
00XG		CPU: received IIM is unknown
00XH		CPU: received FU-type is unknown
00XI		init with FU-RoCo not OK
00XJ		exposure time too short
00XK		CPU: FU mA refuses set data
00XL		NVRAM: tube yield table invalid
00XM		NVRAM: add filter corr table invalid
00XN		NVRAM: wedge filter corr table invalid
00XO		exposure time too long
00XP		exposure time too long
02AB	W	procedure called with wrong parameter
02AC	E	wrong index for table access
02AD	E	wrong do case entry
02AE	W	unknown IIM received
02AF	W	IIM parameter out of range
02CA		error DPRAM too small
02CB		received IIM has invalid number
02CC		domain rx: frame-repeat-counter overflow
02CE		domain rx: signal conflict
02CF		domain tx: timeout (no rety from receiver)
02CG		domain tx: response mailbox type wrong
02CX		domain rx: last-only-rep-counter overflow
02CY		unexpected frame received, domain rx aborted
02CZ		unexpected frame received outside domain rx
02DA		No CPU-access to CAN controller
02DB		CAN-chip reset not acknowledged
02DD		check of CAN-chip DPRAM failed
02DE		unexpected CAN-chip int-pointer
02DF		CAN-chip state undefined

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Error	class	explanation
02DG		CAN-chip error-active after passive
02DH		CAN-chip state error-passive
02DI		CAN-chip state bus-off
02DJ		CAN-chip state DPRAM-error
02DK		CAN-chip state DPRAM-error and passive
02EA	F	interrupt 0: divide by zero
02EB	F	interrupt 1: single step
02EC	F	interrupt 2: NMI
02ED	F	interrupt 3: breakpoint
02EE	F	interrupt 4: overflow exception
02EF	F	interrupt 5: array bounds exception
02EG	F	interrupt 6: unused opcode
02EH	F	interrupt 7: ESC opcode
02EI	F	CAN connection to CU lost
02GA	W	interpolation not possible
02HA	W	kV nominal value out of range: ± (4 % + 1 kV); 3 detections within 30 ms
02HB	E	kV nominal value out of range: 0 kV > U > 170 kV
02HC	W	Z nominal value out of range: ± 1 % ± 0.2; 3 detections within 30 ms; duty cycle range 3 %...30 %
02HD	E	Z nominal value out of range: 0 % > Z > 50 %
02HE	W	kV value during standby too large: > 3 kV for > 400 ms after PREP
02HF	E	kV value during standby too large: > 4 kV for > 400 ms after PREP
02HG	W	kV actual value out of range: ± (4 % + 1 kV); 2 detections within 20 ms
02HH	E	kV actual value out of range: 20 kV > U > 170 kV; 3 detections within 30 ms
02HI	W	E value during standby out of range: 470 V > E > 780 V; 3 detections within 30 ms
02HJ	E	E value during standby out of range: 450 V > E > 800 V; 3 detections within 30 ms
02HK	W	E value during high tension out of range: 400 V > E > 780 V; 3 detections within 30 ms
02HL	E	E value during high tension out of range: 350 V > E > 800 V; 3 detections within 30 ms
02HM	W	converter 1 temperature out of range: 0 °C > T > 85 °C; 3 detections within 30 ms
02HN	E	converter 1 temperature out of range: 0 °C > T > 90 °C; 3 detections within 30 ms
02HO	W	converter 2 temperature out of range: 0 °C > T > 85 °C; 3 detections within 30 ms
02HP	E	converter 2 temperature out of range: 0 °C > T > 90 °C; 3 detections within 30 ms
02HQ	W	high tension tank temperature out of range: 0 °C > T > 80 °C; 3 detections within 30 ms
02HR	E	high tension tank temperature out of range: 0 °C > T > 85 °C; 3 detections within 30 ms
02HS	W	divider test cathode out of range: 45.5 kV > U > 50.5 kV; 3 detections within 30 ms
02HT	E	divider test cathode out of range: 43 kV ≥ U > 53 kV; 3 detections within 30 ms
02HU	W	divider test anode out of range: 45.5 kV > U > 50.5 kV; 3 detections within 30 ms

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Error	class	explanation
02HV	E	divider test anode out of range: 43 kV $\geq$ U > 53 kV; 3 detections within 30 ms
02HW	W	kV anode out of range, asymmetric ?: ± 15%; 2 detections within 20 ms
02HX	E	kV anode out of range, asymmetric ?: ± 15%; 3 detections within 30 ms
02MA	E	state request not accepted because of grid mode
02MB	E	state request not accepted because of error state
02MC	W	state requested by CU unknown
02OA	F	RMX error: timeout
02OB	F	RMX error: memory
02OC	F	RMX error: busy
02OE	F	RMX error: limit
02OF	F	RMX error: context
02OG	F	RMX error: exist
02OH	F	RMX error: state
02OI	F	RMX error: not configured
02OJ	F	RMX error: interrupt saturation
02OK	F	RMX error: interrupt overflow
02OL	F	RMX error: transmission
02OM	F	RMX error: divide by zero
02ON	F	RMX error: overflow
02OO	F	RMX error: type
02OP	F	RMX error: parameter
02OQ	F	RMX error: bad call
02OR	F	RMX error: array bound
02OS	F	RMX error: NDP error
02OT	F	RMX error: illegal opcode
02OU	F	RMX error: emulator trap
02OV	F	RMX error: interrupt table limit
02OW	F	RMX error: CPU xfer data limit
02OX	F	RMX error: wrap around
02OY	F	RMX error: check exception
02OZ	F	RMX error: unknown
02RA	W	grid mode changeover requested during prep
02RB	W	tube switch requested during preparation
02RC	W	requested P out of range
02SA	W	Not enough space at the destination

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Error	class	explanation
02SB	W	Base out of range
02SC	W	PC comm: Value too large
02SD	W	Terminator not found
02SE	W	PC comm: Error in description
02SF	W	PC comm: Item type unknown
02SG	W	PC comm: Internal type unknown
02SH	W	PC comm: Value negative
02SI	W	PC comm: Not space at dest. buffer
02SJ	W	PC comm: Syntax wrong
02SK	W	PC comm: String too long
02SL	W	PC comm: String truncated
02SO	W	PC comm: Unknown Table ID received
02SP	W	PC comm: Access Level too low
02SQ	W	PC comm: Unknown Action requested
02SR	W	PC comm: Routing or Message corrupt
02SS	W	Source Buffer too small for incoming Message
02ST	W	CAN Buffer too small for outgoing Message
02SU	W	PC comm: Access.level is N_A (not available)
02UA	E	HW configuration identifier wrong
02UB	W	Set Up request received during preparation
02WA	W	wrong tube selected
02WB	E	wrong tube selected
02WC	W	EN X C signal faulty
02WD	E	EN X C signal faulty
02WE	W	wrong grid mode selected
02WF	E	wrong grid mode selected
02WG	W	tube arcing detected
02WH	E	tube arcing detected
02WI	W	kV over voltage detected
02WJ	E	kV over voltage detected
03AA	W	Internal parameter error
03AB	W	Wrong parameter from CU
03AC	W	I_e-regulation active on two filaments; only in case of VARIOFOCUS
03AI	W	Wrong IIM received
03BA	W	Coordinates not monotonous; boost adaptation error

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Error	class	explanation
03BB	W	No measurement values for adap. found
03CA		error DPRAM too small
03CB		received IIM has invalid number
03CC		domain rx: frame-repeat-counter overflow
03CE		domain rx: signal conflict
03CF		domain tx: timeout (no rety from receiver)
03CG		domain tx: response mailbox type wrong
03CX		domain rx: last-only-rep-counter overflow
03CY		unexpected frame received, domain rx aborted
03CZ		unexpected frame received outside domain rx
03DA		No CPU-access to CAN controller
03DB		CAN-chip reset not acknowledged
03DD		check of CAN-chip DPRAM failed
03DE		unexpected CAN-chip int-pointer
03DF		CAN-chip state undefined
03DG		CAN-chip error-active after passive
03DH		CAN-chip state error-passive
03DI		CAN-chip state bus-off
03DJ		CAN-chip state DPRAM-error
03DK		CAN-chip state DPRAM-error and passive
03EA	F	CPU interrupt 0
03EB	F	CPU interrupt 1
03EC	F	CPU interrupt 2
03ED	F	CPU interrupt 3
03EE	F	CPU interrupt 4
03EF	F	CPU interrupt 5
03EG	F	CPU interrupt 6
03EH	F	CPU interrupt 7
03EI	F	CAN is unable to send an error to CU
03FA	W	NVRAM: Invalid checksum
03FB	W	NVRAM: Standby filament not found
03FC	F	No NVRAM plugged in
03FD	W	NVRAM empty; battery?
03GA	W	Linint error
03GB	W	Real math. error: real underflow
03GC	W	Real math. error: real overflow

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Error	class	explanation
03GD	W	Real math. error: dword overflow
03GE	W	Real math. error: integer overflow
03GF	W	Real math. error: word overflow
03GG	W	Singular matrix
03HA	F	Unknown hardware
03HB	E/W	Intermediate circuit voltage < 200 V
03HF	W	Undefined analog input channel
03HG	W	I_f-actual out of tolerance: ± 3 %
03HH	E	I_f-setpoint tp large
03HI	E	I_f-actual out of tolerance: ± 500 mA within 250 ms
03HJ	E	I_f-actual out of tolerance
03HK	W	I_f-nominal out of tolerance
03HL	E	I_f-nominal out of tolerance
03HM	E	I_f-nominal out of tolerance
03HN	F	no retrigger received from CU
03IA	W	Adaptation cannot be completed
03IC	W	No I_e-adaptation measurement values
03ID	W	I_e-adaptation values not evaluable
03KA	W	Condi.-X-Ray mode without mAs parameter
03MA	W	Undefined status
03MB	W	Status change not allowed
03MC	W	FU init data not expected
03OA	F	RMX exception:E$TIME
03OB	F	RMX exception:E$MEM
03OC	F	RMX exception:E$BUSY
03OD	F	RMX exception:E$LIMIT
03OE	F	RMX exception:E$CONTEXT
03OF	F	RMX exception:E$EXIST
03OG	F	RMX exception:E$STATE
03OH	F	RMX exception:ENOTCONFIGURED
03OI	F	RMX exception:E$INTERRUPT$SATURATION
03OJ	F	RMX exception:E$INTERRUPT$OVERFLOW
03OL	F	RMX exception:E$ZERO$DIVIDE
03OM	F	RMX exception:E$OVERFLOW
03ON	F	RMX exception:E$TYPE

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Error	class	explanation
03OK	F	RMX exception:E$TRANSMISSION
03OO	F	RMX exception:E$PARAM
03OP	F	RMX exception:EBADCALL
03OQ	F	RMX exception:E$ARRAY$BOUND
03OR	F	RMX exception:ENDPERROR
03OS	F	RMX exception:E$ILLEGAL$OPCODE
03OT	F	RMX exception:E$EMULATOR$TRAP
03OU	F	RMX exception:E$INTERRUPT$TABLE$LIMIT
03OV	F	RMX exception:E$CPUXFER$DATA$LIMIT
03OW	F	RMX exception:ESEGWRAP$AROUND
03OX	F	RMX exception:E$CHECK$EXCEPTION
03OY	F	unknown RMX exception
03PA	E	I_e zero measured
03PB	W	I_e out of tolerance: ± 10 % (I_e > 5 mA, exp. time ≤ 44 ms) or ± 3 % (I_e > 5 mA, exp. time > 44 ms)
03PC	E	I_e out of tolerance: ± 30 % (I_e > 5 mA, exp. time > 44 ms)
03PD	W	Setpoint for I_e-regulation incorrect
03PE	F	Emergency off! Grid not closed!
03SC	E	PC comm: Value too large
03SE	F	PC comm: Error in description
03SF	W	PC comm: Item type unknown
03SG	E	PC comm: Internal type unknown
03SH	F	PC comm: Value negative
03SI	F	PC comm: No space at dest. buffer
03SJ	W	PC comm: Syntax wrong
03SK	W	PC comm: String too long
03SL	W	PC comm: String truncated
03SM	W	Internal type definition not known
03SN	W	value is neg., absolute values only used
03SO	W	PC comm: Unknown Table ID received
03SP	W	PC comm: Access Level too low
03SQ	W	PC comm: Unknown Action requested
03SR	W	PC comm: Routing or Message corrupt
03SS	W	Unknown Action requested
03ST	W	Routing Info present or Mess. corrupt
03SU	W	PC comm: Access. level is N_A (not available)

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Error	class	explanation
03SV	W	Access Level too low
03SW	W	Unknown Table ID received
07CA		CAN: case-selector error
07CB		CAN: invalid CAN ID%u
07CC		CAN: frame rep. overflow IIM%u
07CD		CAN: no RTR from CU
07CE		CAN: rx signal conflict IIM%u
07CF		CAN: tx timeout
07CI		CAN: IMPOSSIBLE ERROR
07CP		CAN: CPU: PXerr %d %s(%d)
07CR		CAN: CPU: message request fail
07CS		CAN: CPU: message send error
07CY		CAN: rx abort IIM%u
07CZ		CAN: unexpected frame (IIM%u)
07DA		CAN: chip access error
07DB		CAN: chip reset error
07DC		CAN: chip reset release error
07DE		CAN: illegal interrupt pointer
07DF		CAN: chip state undefined
07DG		CAN: chip err act. after pass.
07DH		CAN: chip state error passive
07DI		CAN: chip state bus-off
07DJ		CAN: chip DPRAM Error
07DK		CAN: chip DPRAM Error & passive
07DL		CAN: unexpected interrupt
07LA	W	Received IIM unknown
07LB	W	Rotor Control stator number out of range
07LC	W	Rotor Control stator not available
07LD	E	Rotor Control stator 1 readback failed
07LE	E	Rotor Control stator 2 readback failed
07LF	E	Rotor Control stator 3 readback failed
07LG	W	Rotor Control speed value out of range
07LH	E	Rotor Control speed set timeout
07LI	W	Rotor Control max. stator loading exceeded
07LJ	E	Rotor Control max. rotation time exceeded

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Error	class	explanation
07LK	W	AMPLIMAT chamber number out of range
07LL	W	AMPLIMAT field number out of range
07LM	W	Wrong AMPLIMAT delay value
07LN	E	Door contact grounded
07LO	E	Cooling unit contact grounded
07LP	W	Ionization voltage out of range
08CA		CAN: case-selector error
08CB		CAN: invalid CAN ID %u
08CC		CAN: frame rep. overflow IIM%u
08CD		CAN: no RTR from CU
08CE		CAN: rx signal conflict IIM%u
08CF		CAN: tx timeout
08CI		CAN: IMPOSSIBLE ERROR
08CP		CAN: CPU: PXerr %d %s(%d)
08CR		CAN: CPU: message request fail
08CS		CAN: CPU: message send error
08CY		CAN: rx abort IIM%u
08CZ		CAN: unexpected frame (IIM%u)
08DA		CAN: chip access error
08DB		CAN: chip reset error
08DC		CAN: chip reset release error
08DD		error when offset out of range in APR data structure while surging APR
08DE		CAN: illegal interrupt pointer
08DF		CAN: chip state undefined
08DG		CAN: chip err act. after pass.
08DH		CAN: chip state error passive
08DI		CAN: chip state bus-off
08DJ		CAN: chip DPRAM Error
08DK		CAN: chip DPRAM Error & passive
08DL		CAN: unexpected interrupt
08IE		Init: wrong IIM during setup
08IF		no message request for test task
08IG		no message send for test task
08RA		no message receive display task
08RB		no message release display task

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Error	class	explanation
08SA		error when requesting message object to CAN_tx_task from scan task
08SB		error when requesting message object to CAN_tx_task from test task
08SC		error when sending message to CAN_tx_task from scan task
0ACA	CAN:	case-selector error
0ACB	CAN:	invalid CAN ID %u
0ACC	CAN:	frame rep. overflow IIM%u
0ACD	CAN:	no RTR from CU
0ACE	CAN:	rx signal conflict IIM%u
0ACF	CAN:	tx timeout
0ACI	CAN:	IMPOSSIBLE ERROR
0ACP	CAN:	CPU: PXerr %d %s(%d)
0ACR	CAN:	CPU: message request fail
0ACS	CAN:	CPU: message send error
0ACY	CAN:	rx abort IIM%u
0ACZ	CAN:	unexpected frame (IIM%u)
0ADA	CAN:	chip access error
0ADB	CAN:	chip reset error
0ADC	CAN:	chip reset release error
0ADE	CAN:	illegal interrupt pointer
0ADF	CAN:	chip state undefined
0ADG	CAN:	chip err act. after pass.
0ADH	CAN:	chip state error passive
0ADI	CAN:	chip state bus-off
0ADJ	CAN:	chip DPRAM Error
0ADK	CAN:	chip DPRAM Error & passive
0ADL	CAN:	unexpected interrupt
0AIF	initialization failed	
0ALA	acceleration count limit exceeded	
0ALC	current limit exceeded	
0ALH	intermediate current %u mA (>%u)	
0ALL	intermediate current %u mA (<%u)	
0ALO	intermediate voltage %u V (>%u)	
0ALT	temperature limit exceeded	
0ALU	intermediate voltage %u V (<%u)	
0AOE	CPU:	PXROS error %d

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Error	class	explanation
0AOF	CPU:	PXROS error %d %s(%d)
0ARC		rotation check failed
0ARI		invalid rotation request: %u
0ARM		rotation detector not present
0ART		rotation request timeout
0ATE		stator %u hardware error
0ATF		stator %u switching failed
0ATI		invalid stator request: %u
0ATR		stator change with rotating anode
0AUI		unknown message from CU: IIM %u
0AUM		unexpected message from CU: IIM %u
0AWT	CPU:	watchdog timeout
0AXX		IMPOSSIBLE ERROR
0DCA	CAN:	case-selector error
0DCB	CAN:	invalid CAN ID %u
0DCC	CAN:	frame rep. overflow IIM%u
0DCD	CAN:	no RTR from CU
0DCE	CAN:	rx signal conflict IIM%u
0DCF	CAN:	tx timeout
0DCI	CAN:	IMPOSSIBLE ERROR
0DCP	CAN:	CPU: PXerr %d %s(%d)
0DCR	CAN:	CPU: message request fail
0DCS	CAN:	CPU: message send error
0DCY	CAN:	rx abort IIM%u
0DCZ	CAN:	unexpected frame (IIM%u)
0DDA	CAN:	chip access error
0DDB	CAN:	chip reset error
0DDC	CAN:	chip reset release error
0DDE	CAN:	illegal interrupt pointer
0DDF	CAN:	chip state undefined
0DDG	CAN:	chip err act. after pass.
0DDH	CAN:	chip state error passive
0DDI	CAN:	chip state bus-off
0DDJ	CAN:	chip DPRAM Error
0DDK	CAN:	chip DPRAM Error & passive

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Error	class	explanation
0DDL		CAN: unexpected interrupt
0DLA	W	received IIM unknown
0DLB	W	wrong bidirectional lines output value
0DLC	W	value for K5 – K12 out of range
0DLD	W	RGDV value out of range
0DLE	E	RGDV readback failed
0DLF	W	wrong sync. contact value
0DLG	W	wrong handswitch enable value
0DLH	E	S1/S2 switch active during startup
0ECA		CAN: case-selector error
0ECB		CAN: invalid CAN ID %u
0ECC		CAN: frame rep. overflow IIM%u
0ECD		CAN: no RTR from CU
0ECE		CAN: rx signal conflict IIM%u
0ECF		CAN: tx timeout
0ECI		CAN: IMPOSSIBLE ERROR
0ECP		CAN: CPU: PXerr %d %s(%d)
0ECR		CAN: CPU: message request fail
0ECS		CAN: CPU: message send error
0ECY		CAN: rx abort IIM%u
0ECZ		CAN: unexpected frame (IIM%u)
0EDA		CAN: chip access error
0EDB		CAN: chip reset error
0EDC		CAN: chip reset release error
0EDE		CAN: illegal interrupt pointer
0EDF		CAN: chip state undefined
0EDG		CAN: chip err act. after pass.
0EDH		CAN: chip state error passive
0EDI		CAN: chip state bus-off
0EDJ		CAN: chip DPRAM Error
0EDK		CAN: chip DPRAM Error & passive
0EDL		CAN: unexpected interrupt
0ELA	W	received IIM unknown
0ELB	W	wrong bidirectional lines output value
0ELC	W	value for K5 – K12 out of range

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Error	class	explanation
0ELD	W	RGDV value out of range
0ELE	E	RGDV readback failed
0ELF	W	wrong sync. contact value
0ELG	W	wrong handswitch enable value
0ELH	E	S1/S2 switch active during startup

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8. Power supply

Switch-on not possible:

- ENF1 released.
- ENF1 not switched on (visual check).
- ENF2 released by low-voltage supply
  filament circuit
  tube extension
  external components supply.
- FNF2 not switched on (visual check).
- "ON" circuit EN100 defective.

Phase supervision

a) Without mains adaptation transformer:

- Phase L1 is missing: Mains contactors ENK2 and ENK1 cannot be activated.
- Phase L2 is missing: The generator can be switched on but does not go into the READY state.
  The filament-circuit supply is missing.
  There is an error message from function unit kV.
- Phase L3 is missing: "ON" circuit without supply voltage.

Fault tracing:

Check leads and fuses up to the mains supply.

b) With mains adaptation transformer:
In case at least one phase at the primary end is missing, the generator cannot be switched on. If there is a problem concerning the leads at the secondary end, refer to a).

After switch-on or attempted switch-on:

The generator cannot be brought into the READY state (e.g. no desk display).

Check the low-voltage supply.

- ENF1 released:
  Ground fault/short-circuit of one/several phase(s).
  Check ENK2 and, if necessary, the contacts of ENK1.
  Check the leads and the mains adaptation transformer.
  Have contacts ENK2 or ENK1 dropped out?
  Check visually. Be careful when doing so since the unit is still connected to mains.
- Missing voltage of intermediate circuit:
  The damping resistors are unsoldered which was caused by overcurrent during switch-on.
  Cause: Short-circuit in the converter, defective charging capacitors, mains-filter capacitors or rectifiers.
  Unsoldering happens about 45 sec. after switch on.

The damping resistors are unsoldered because the converter was active and ENK1 was not switched on although activated by the software.
Probably termination of exposure.

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This procedure can only happen once since the generator cannot go into STANDBY when intermediate-circuit voltage E is missing.

In case intermediate-circuit voltage E is present, ENK1 is activated by the software of the kV-control and remains activated for the complete time the unit is in operation.

In case of high impedance or when the tolerance of the symmetry resistors of the intermediate-circuit capacitor battery is too large, capacitors may be destroyed by overvoltage. In case ENK1 has already been activated, ENF1 will probably release.

ENF3 is released by the rotor control units.

The release of ENF2 switches the generator off since the supply voltage for the "ON" circuit and, consequently, the supply voltage of contactors ENK2 and ENK1 is interrupted.

9. Converter

See drawings: Z1–3.2 / 3.3

Z2–3

9.1. Problem overview

Resonant capacitor(s) defective:

- At least one of the two capacitors is ineffective:
  High voltage is not possible with the 50 kW version.
  Asymmetry or too low kV with the 65/80/100 kV versions.
- Short-circuit on one of the two capacitors (in case both capacitors are concerned, ENF1 will be released):
  Low resonant-circuit frequency.
  The IGTBs can break because of overcurrent.
  Overvoltage at the resonant capacitor which is intact.
  kV overswing.
  DC short-circuit current possible because of resonant current which has not yet died off.

Snubber diode on kV power board defective:

- High impedance:
  IGBTs defective. DC short-circuit current causes the release of ENF1.
- Short-circuit:
  IGBTs defective. DC short-circuit current causes the release of ENF1. The resistors of the protective wiring might be destroyed in advance.

The fan for the IGBT heat sinks fails:

The temperature is measured and a (warning) message is given via the software.
The converter is switched off when the limit values are exceeded (error).
This might be caused by failure of the supply of the fan.

The NTC resistor for temperature measurement is supervised via the software with respect to logical values.
The valid temperature range is between these error conditions.

Open/shorted measuring circuits or any values going beyond the temperature limits will cause an error message.

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9.2. Hardware problems

An ENF1 tripout will be the 'message' if something serious happened in the converter. If something like this occurs, replace the whole kV power unit. We want to have the complete unit to get a chance of researching the problem.

- Before the ENF1 is pushed back to the on position check if all contacts of ENK1 1–2, 3–4 and 5–6 are open in the non-energized condition of the relay. If not, replace the relay before you switch on ENF1 and proceed with other test activities.

The first thing to look at will be the emitter-collector / emitter-gate impedance at every IGBT 1 to 4. If all 4 of a kV power unit are not 0 Ohms (50 kW) and none of the 8 of a double converter generator is on 0 Ohms one should not suspect the power unit(s) (so far).

Are there any damages on the driver PCB('s)?

- Check the snubber diodes V 500 / 501 / 502 / 503 for short-circuit. If one has a short-circuit some of the resistors linked to the damaged diode(s) must also be open or have some overheat characteristics.

The second step should be the measurement of the rectifier(s) EQV5 (E2QV5). It could have been damaged from overvoltage (surge). Look for short-circuits and, after the next switch-on, for error codes 02HI and/or 02HJ (E_value out of range = DC power supply) in the error log index.

02HI = 470 V > E_value > 780 V in standby ≥ 30 ms
02HJ = 450 V > E_value > 800 V –dto–

- Remove the driver PCB('s) to look at the current tracks for short-circuit (insulation damaged?)
- Check all 4 DC capacitors for short-circuit. Are the DC symmetry resistors R1 + R11 ok (47 kΩ)?
- Are the frequency capacitors C3 and C13 ok?
- If everything seems to be fine so far reinstall the kV_driver PCB.
- Switch on ENF1.
- Switch on the generator.

With switch-on the converter DC supply will be charged via the dumping (spring) resistors EN R1, R2 and R3. If there is still any kind of short-circuit in the machine we could not measure with a (low voltage) Ω-meter and/or there is a part in the generator which fails when the AC or DC increases a certain level, one or two of the spring resistors might become very hot and will open.

If it does not happen, measure the converter DC supply at ENK2 41(+) and 42(–). It should have a value between 480 V and 750 V.

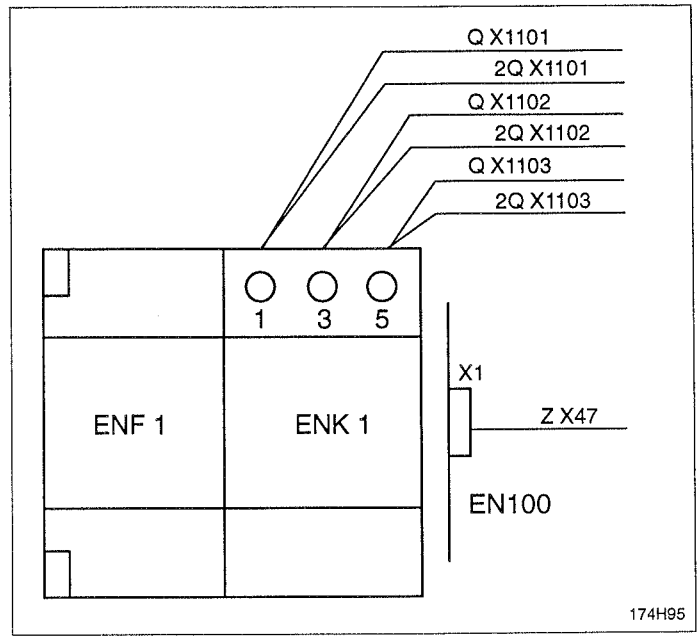
If the generator is in a stable standby condition, proceed with the converter driver test without converter DC supply.

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9.3. kV driver test

Caution!
Before this driver test can be carried out the kV power unit(s) must be disconnected from the mains supply (leads of unit(s) EQ/E2Q to ENK1 :1, :3, :5).

This safety measure is also valid for the chopper test to guarantee that the measurements can be carried out without any risks involved.



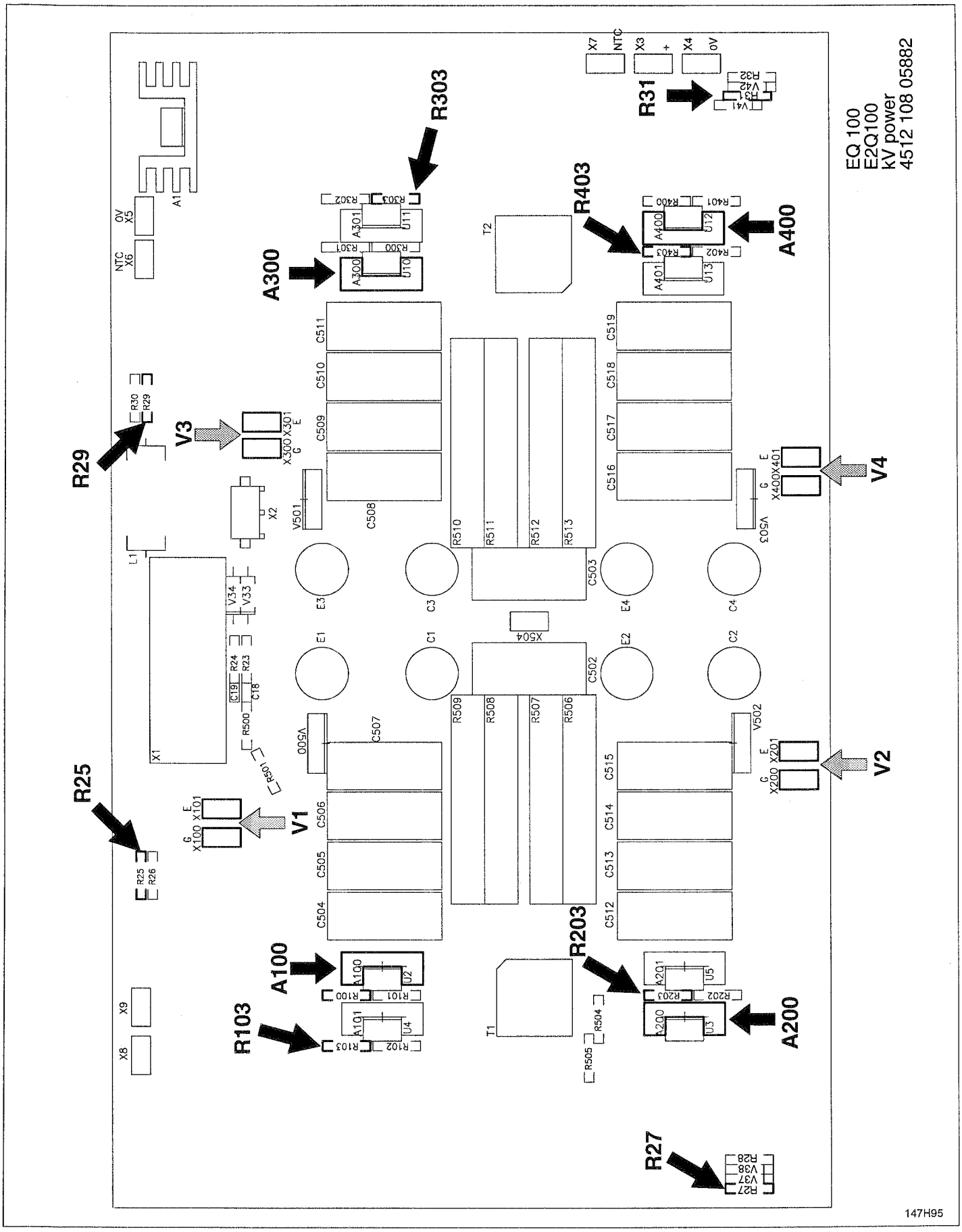
The kV driver test is software controlled via PC. Due to the missing PREP and exposure requests the signals **EN_X_C/** and **CTRL_X_C/** have to be set low-active at the backpanel at locations **X76** and **X74** (see drawing Z2–5.1/2).

Caution!
Do not forget to remove these connections after the test. Otherwise kV will start immediately with the PREP command in normal application mode.

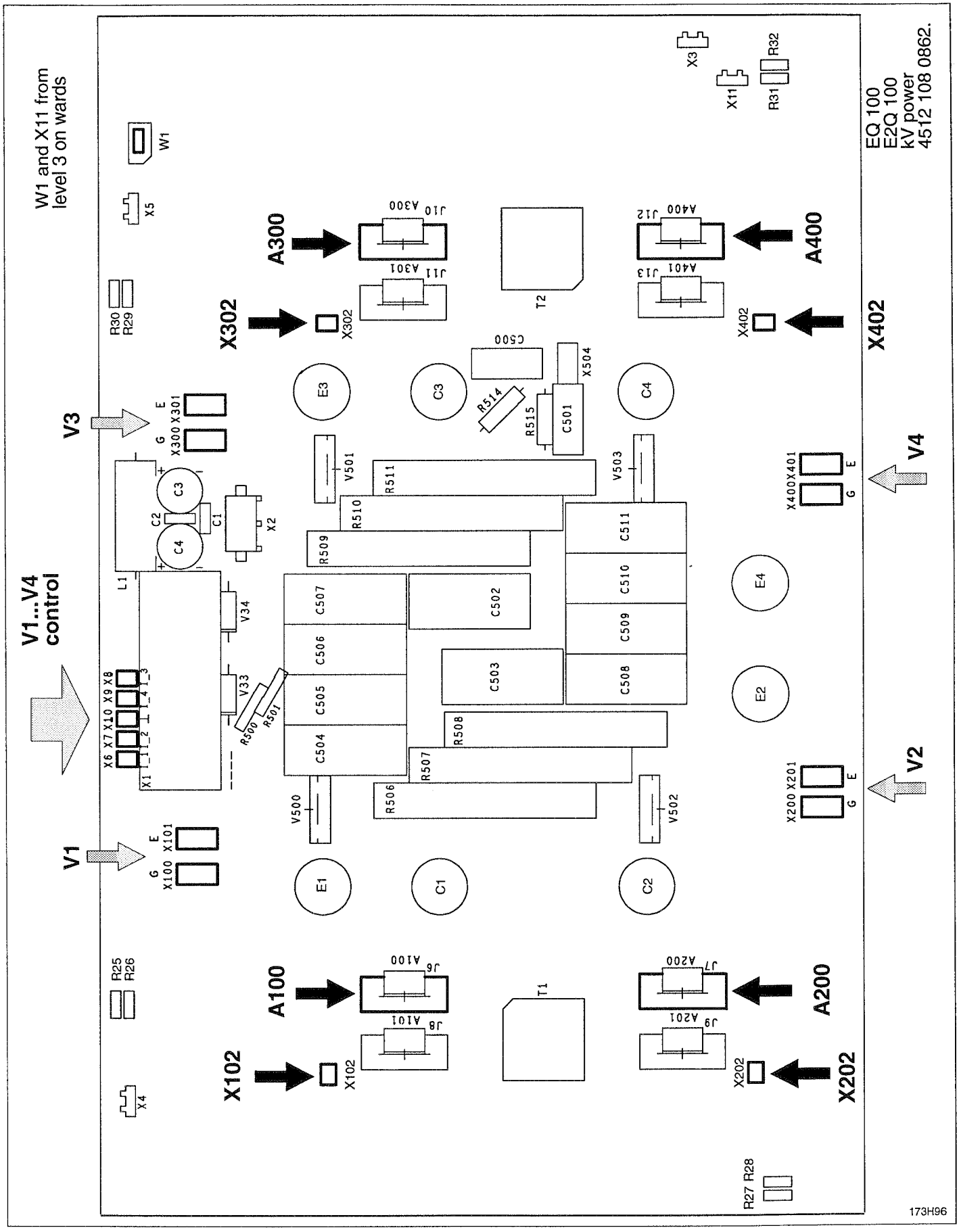
- Switch on the generator.
  Ignore error codes 02HI and 02HJ now, the DC supply is off and these error must come up.
- Check whether the gate voltage is about –14.2 V ±0.3V against emitter for every IGBT.
- Check the ±15 V supply for the IGBT drivers now. Drivers 1 and 2 are supplied by chopper 1 while drivers 3 and 4 are supplied by chopper 2. The common zero point is the emitter.

Emitter	+15 V supply at heat sink	–15 V at resistor		
E1, X101	A100	R103 upper position	or	X102 (Q100 ≥ 4512 108 08621)
E2, X201	A200	R203 upper position		X202
E3, X301	A300	R303 lower position		X302
E4, X401	A400	R403 upper position		X402

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Test of control signal(s) and driver(s) behaviour:

The range of the control signal is + 3.7 V ± 0.2 V for the on condition and + 1.2 V ± 0.2 V for the off condition at the specified measuring point against generator ground (see drawings of principals and PCB layout).
The range of the driver signal (gate against emitter) is – 14.2 V ± 0.3 V for the off condition and + 13.5 V ± 0.3 V for the on condition.

- Select menu ***"FU_kV/ Faultfind/ Functional Test/ Test Converter"*** at the service PC.
  The question **[power supply mains – E disconnected ?:]** will come up.
  Answer with 'yes' (type Return twice) and transmit with [F2].

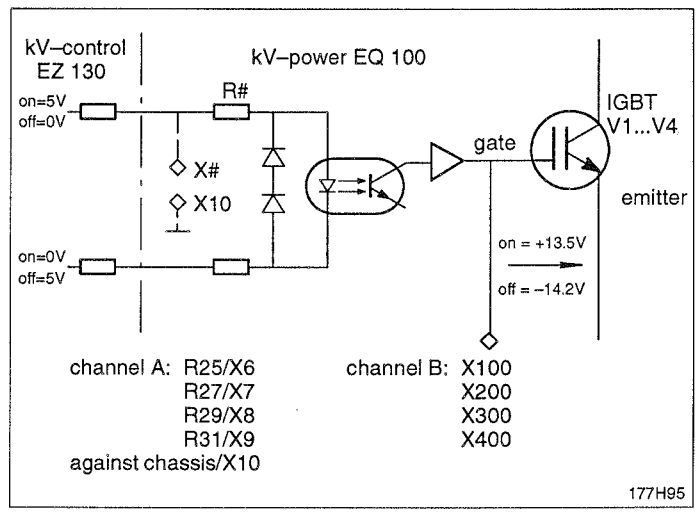
If the test takes longer than 10 minutes it may happen, that the test will be denied by the kV_control. This happens if the DC voltage = E-value increases 5 V (the DC capacitors are slowly charged by the ± 15 V of the drivers). Then short-circuit the DC at collector C1 and emitter E2.

Do not establish a constant short-circuit to avoid a big problem after the test!

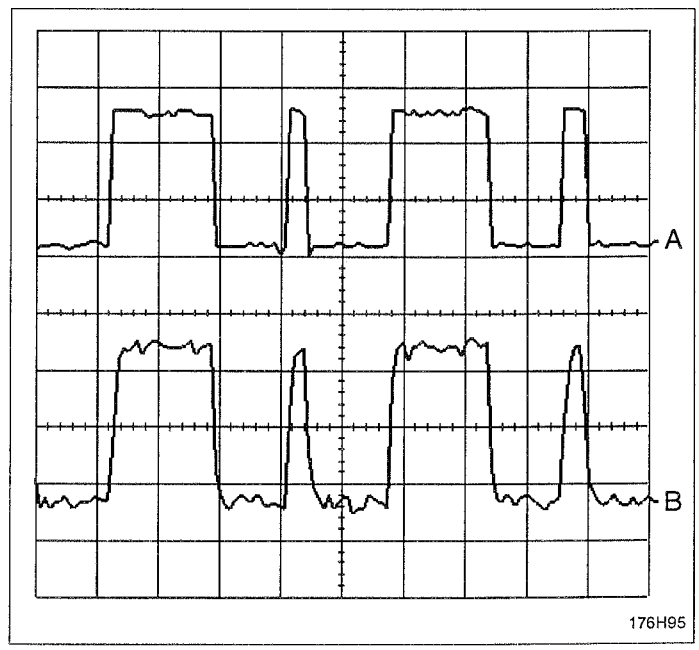
The test itself is short. The pulse time is 2.5 sec long, but the PC screen says **[completed]** after 5 seconds.
kV_control sends pulses for 5 seconds, but the hardware timer on the kV_control inhibits more pulses after 2.5 ms. Within this time the actual kV have to be on the nominal value.

Test 1 : in– and output:

- Put a 2 beam scope to every measuring point of the control signals (channel A) and to every gate belonging to the inputs (channel B).
  Measuring points X6...X10 are present at the new kV power unit 4512 108 0862x only.
- Trigger with the negative slope of channel A, take 10..50µs/Div.



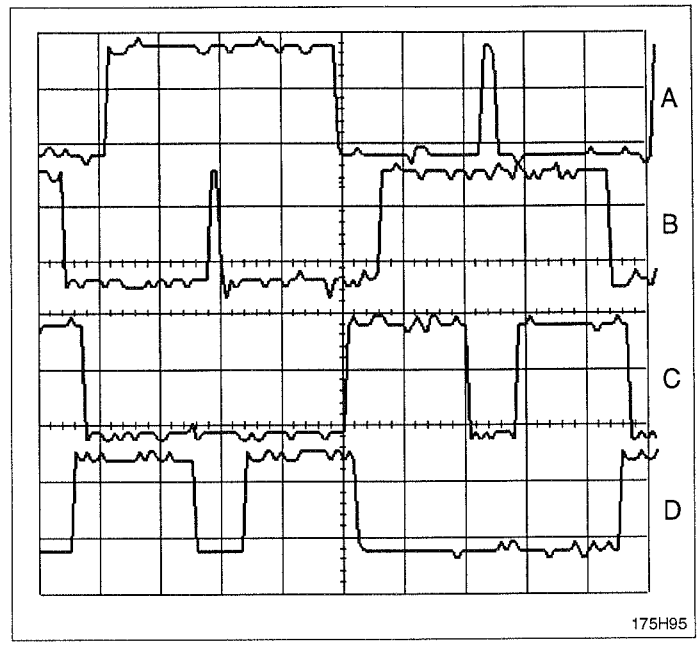
The 'needle' shape of the attached scope picture is due to the resolution of the scope, which has been magnified thereafter.



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Test 2 : inputs only:

- Check if the signal pattern of all 4 control signals look the same as on the diagram. Of course, only 2 channels be seen at the same time, but the "on's" and "off's" **must** be equal to the drawing. There should **never** be an on (low active) of A (R25) + C (R27) and **never** be an on of B (R31) + D (R29).



Test 3 : only for 65/80/100kW with two kV power units:

- Compare control signals of both units.
  The signals at R25 of unit 1 must be absolutely equal to the signal at R25 at unit 2.

If no problems are visible = all waveforms are as they should be:

- Switch off the generator with **ENF1**.
- Remove links **EN_X_C/** and **CTRL_X_C/** at the backpanel **X76** and **X74**.
- Remove scope probes.
- Close the kV power part(s).
- Connect mains power lines at ENK1 :1 :3 :5.
- Switch on ENF1 and the generator.

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10. Functional description of function unit mA

Tube data must be loaded as a data set from floppy disk via PC and central unit CU to into function unit mA.

The procedures described below cannot be carried out before the complete data set for the tube housing assembly is present in central unit CU.

Before the tube adaptation can be started, tube conditioning must be implemented.

With the present generator release the conditioning must be implemented manually.

Later on the conditioning program will take place automatically.

Before adaptation can be started, the mA offset value of the mA measuring circuit must be determined.

This offset value consists of two components:

1. A current of 4 mA is impressed upon the mA measuring circuit which is used for continuous calibration (during STANDBY about once per minute).
2. In addition to this the kV measuring circuit delivers an offset current depending on the kV.

To measure this total value an exposure must be released with 40 kV without filament current. The current measured is the correction value for all standard exposures (4 mA, measuring circuit current depending on the kV).

As opposed to the standby filament current value of the predecessor versions of the generator, the standby filament current value of the OPTIMUS generator is not fixed.

It is determined for each focus individually. A 40 kV exposure must be released with the focus to be measured while all other foci are switched off.

The filament current must be changed until an emission current of 100 µA is obtained.

The associated filament current value is the individual standby filament current (1% to be substracted so that the fluoroscopic current of any of the other foci is not affected).

The adaptation program takes place fully automatically.

Based on 120 single exposures for each focus a data field is created in the CMOS of function unit mA. The adjustments for all other exposures are interpolated from this data field during operation.

During the adaptation procedure any limit values such as maximum filament current, maximum kV, maximum tube load, maximum output, current of the generator etc. are taken into account.

Boost adaptation

Boost time determination (positive boosting).

With the predecessor versions of the generator, a **calculated boost current** was added to the exposure filament current for a **fixed time** of 400 ms.

With OPTIMUS generators the boost current is also fixed but with a **variable time**.

The amount of the boost current is the sum of the maximum filament current (of the respective filament) plus 2000 mA.

To determine the time values an exposure must be started in the kV isowatt point (determined from tube and generator parameters).

As soon as the 100% kV value is reached, the maximum filament current plus 2000 mA is adjusted by function unit mA. The emission current is measured every 2 ms until the maximum tube current or the maximum possible generator current is reached.

In case this procedure takes too long (warming up of the tube), the measurement is continued with a second exposure after a sufficient period of time has passed.

The measurement starts again at the value obtained last.

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An innovation of the OPTIMUS generator is the determination of the **negative boosting** (blanking of the filament current).

The measurement is started with the same kV isowatt exposure which is used for the determination of the positive boost time but with maximum filament current.

As soon as the 100% kV value is reached, the maximum filament current of the filament circuit is abruptly reduced to 500 mA.

Every 2 ms the emission current is measured until a value of 100 µA is obtained.

The values for the blanking times are required for techniques such as, for instance, cine.

A filament current value of 500 m must not be exceeded for otherwise the output to supply a gridswitch box (which might be present) is too low.

The following procedure takes place after the generator has been switched on:

Function unit mA initializes itself and afterwards establishes connection with central unit CU via CAN.

For 3 seconds all foci are boosted with their respective specified maximum filament current. Then blanking of the filament current (500 mA) takes place for a variable period of time (derived from negative boost adaptation) to bring the filament current to the STANDBY value.

The change of the filament current value upon a change of the focus which was the usual routine for the predecessor versions of the OPTIMUS generator does no longer take place – all STANDBY values remain constant.

During operation the following procedure takes place after the release of PREP:

- The filament current is raised from the individual STANDBY filament current which depends on the focus to the boost current.

The switch-on time of the boost current results from the difference between STANDBY and intermediate filament current.

- The intermediate filament current is a calculated value. It is calculated in such a way that the filament current and thus the filament temperature is brought to exposure level when the boost current is switched off for 50 ms directly at the end of the preparation phase (RQ_SN_X/ already active) and/or directly before high voltage is switched on (RQ_SN_X/ active when the patient is quiet).
- During exposure the filament current is regulated as required.
- At the end of exposure the filament current is reduced to the minimum value of 500 mA (negative boosting) for a short time.

  At the same time the temperature of the filament abruptly drops to a level which corresponds to the level of the intermediate filament current.

  Afterwards heating takes place with the intermediate filament current.

  Now the tube would be ready for the next exposure with the same preparation.
- In case preparation is released, negative boosting takes place until heating can go on with the STANDBY filament current.

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11. CAN bus

All the intelligent assemblies/pc boards communicate via the CAN bus. There they are connected in parallel to the two lines CAN_L (low) and CAN_H (high).

The data are serially transmitted in the form of so-called frames.

Levels in quiescent state against chassis:

- CAN_L: 2.5 V
- CAN_H: 2.5 V

Levels during data transmission against chassis:

- CAN_L: 0.50 ... 2.25 V
- CAN_H: 2.75 ... 4.50 V

} Both levels are opposite. The difference must be greater than 1.5 V!

Test points generator CAN:

- CAN_L: EZX71
- CAN_H: EZX72
- Chassis: EZX5

Test points system CAN:

- S_CAN_L: EZX42:2
- S_CAN_H: EZX42:7
- Chassis: EZX42:3

Reference: Z1–5.1, Z2–5.1/5.2

Symptoms of errors:

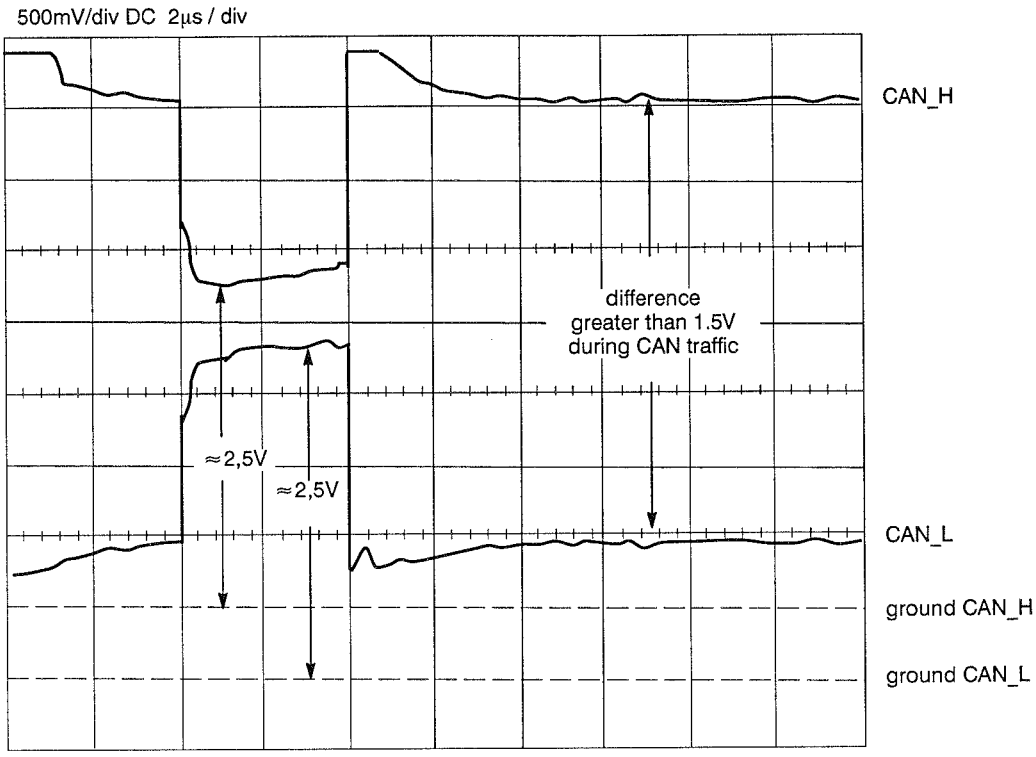
- The generator is inoperable.
- The red LED of one or more of the assemblies/pc boards is flashing.
- Parameter settings on the control desk are accepted and displayed with a considerable delay.
- In the error memory there are several entries which in the code begin with 00C (apart from 00CJ) or the error description contains a reference to signal conflicts.

Error localization:

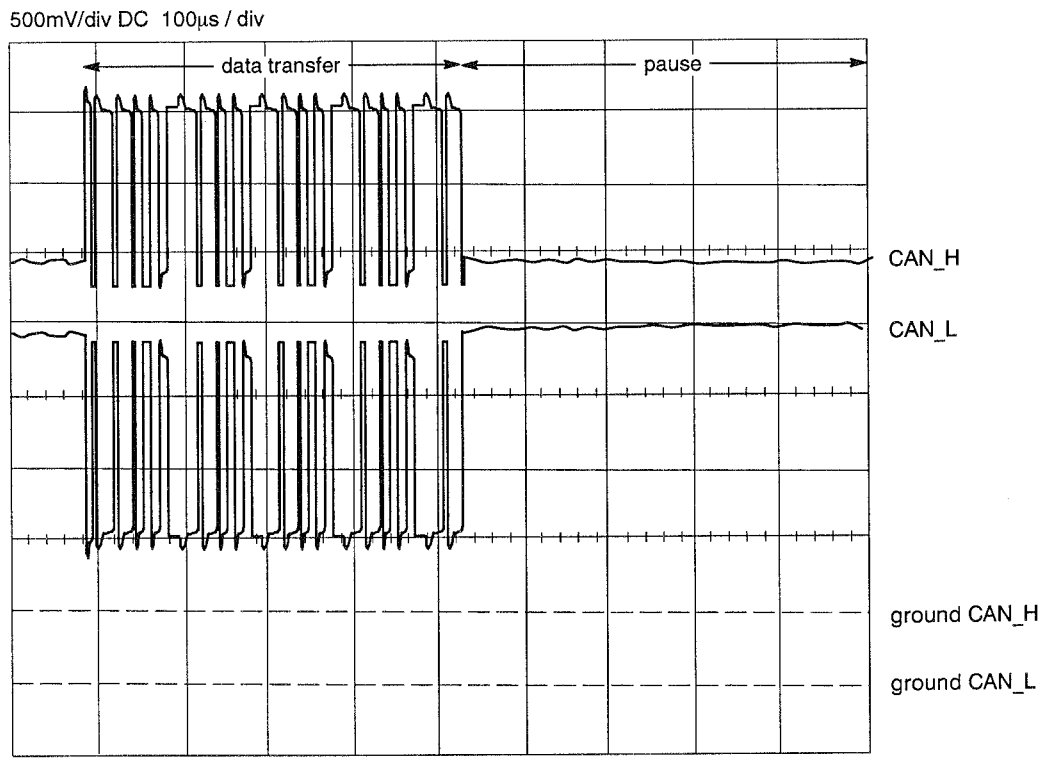
- Entries in the error memory clearly draw attention to the fact that the assembly and pcb are not communicating properly or not at all.
- Control measurement of CAN levels with an oscilloscope during data transmission and in the quiescent state.
  Data transmission is triggered by pressing any desk button.
  If the levels are outside the tolerance or are not symmetrical, the CAN driver of an assembly/pcb is faulty.
  Since all the users are connected to the bus in parallel, the troublemaker can only be found by disconnecting one user after another.
  Disconnection may only take place with the generator switched off.

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CAN levels with a high temporal resolution:
(Diagram 1)



CAN levels with low temporal resolution:
(Diagram 2)



197H96

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12. Incorrect exposure indicator

General causes:

On the control desk an incorrect exposure is indicated if an exposure cannot be terminated according to the parameters set. Frequent causes of underexposure are the following:

- The operator has let go of the release switch prematurely.
- Tomography time of the unit does not coincide with the exposure time of the generator. Permissible tolerance: ± 10%
- Measuring chamber incorrectly programmed, not connected or faulty.
  Check the following:
  - RGDV programming
  - Programming of AMPLIMAT sensitivity
  - Programming of EZ150 Basic Interface (Gain, 15 V/40 V supply)
  - Programming of screen–film combination (Data Sets 1...5)
- The APR selected is not matched to the technique used or the screen–film combination.
  Check the following:
  - APR programming

The standard APRs supplied have parameters which are generally matched to a 400–type screen–film combination. If the standard APRs are used, the exposure parameters will have to be changed according to the speed of the screen–film combination actually used.
This also applies if an automatic technique is programmed as the preferred technique. In automatic techniques the mAs and ms–parameters are used for Fault Exposure Detection.

Fault exposure detection AEC/TDC:

To protect patients there are 3 monitoring systems for automatic techniques:

1. Maximum mAs product
2. Maximum exposure time or backup time
3. Fault Exposure Detection

The maximum mAs product can be set via xrgscope.
The fault exposure detection can be switched on or off via xrgscope. Irrespective of this, fault exposure detection is not performed if levels fall below certain limits.

AEC/AECF limits:

- Maximum mAs product: 580 mAs (default)
- Maximum exposure time: 4 s
- Backup time AEC: Exposure time based on 10 times the mAs of the respective manual technique (kV–mAs). 4 s after overriding.
- Backup time AECF: 10 times the exposure time of the respective manual technique (kV–mAs).
- Fault Exposure Detection: ≤ 4% dose at 10% backup time

Fault Exposure Detection is ignored under the following circumstances:

- Backup time: ≤ 100 ms (≤ 10 ms at 10%)
- Switch–off voltage (dose): ≤ 610 mV (≤ 24.4 mV at 4%)

If there is a fault an exposure is aborted after about 10% of backup time. If the Fault Exposure Detection fails to respond in the event of a fault, shutdown takes place after reaching backup time or maximum exposure time or max. mAs product.

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TDC limits:

- Maximum mAs product: 580 mAs (default)
- Exposure time: 0.3 ... 6 s
- Fault Exposure Detection: ≤ 10 ... 4% dose for 10 times the sample time

$$\text{Dose minimum} = \frac{10 \times \text{sample time}}{\text{exposure time (corr.)}} \times 40\% \text{ nominal dose}$$

- Backup time: Exposure time
- Sample time: 25 ... 60 ms = 1% exposure time (corr.), min. 25 ms
- Sample steps: 12 ... 100

Fault Exposure Detection is ignored under the following circumstances:

- Exposure time: < 1 s

In the event of a fault the exposure is aborted after approx. 11 times Sample Time. If the Fault Exposure Detection fails to respond in the event of a fault, shutdown takes place after reaching the backup time or the max. mAs product.

The switch–off voltage should be at least 1.2 V to guarantee good TDC regulation. Program the higher gain factor on EZ150 BASIC INTERFACE (≥ 4512 108 05964) if necessary.

Programming possibilities:

- Menu *"Program/ Application Limits/* ***X–Mode Limits****"*:
  X–Ray Mode: AEC ... TDC Max. Current Time Product Limit: 580 mAs
- Menu *"Program/ Dose Rate Control/ Fault Exposure Detection/* ***AEC ... TDC****"*: on – off

Aids to fault finding:

Menu *"Faultfind/ Logging Table/ X–Ray Log/ Dose Rate Control Logging/ ...*

.../ **Read Actual Status**": Technique and parameters of the last exposure

.../ AEC/ **AEC Calculation**": Data of the selected APR with AEC or AECF

.../ AEC/ **AEC Trace**": Control values of the last AEC exposure

.../ TDC/ **TDC Calculation**": Data of the selected APR with TDC

.../ TDC/ **TDC Trace**": Control values of the last TDC exposure

Adjustment possibilities:

- Menu *"Adjust / Dose Rate Control / TDC AMPLIMAT":*

  P gain factor (def. 50):
  i gain factor (def. 8):
  d gain factor (def. 5):
  } Don't change any value here without order from DMC Hamburg!

  min. sample time (def. 40) [ms]: 25 ... 65

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13. Mnemonic and routing list

Example:

MNEMONIC	explanation chain value measuring point trigger point remarks part of supply
AC_0V_XG	mains supply 0 V X-ray generator ENX1102–EZX13:2–EZ102X1:DBZ4–EZ119X1:DBZ24 EZX14:2– EZX15:2–EWRX21:2
AC_230V_L1	mains supply 230V AC phase 1 ENF3:L1–EZX13:1–EZX102X1:DBZ2 EZX14:1– EZX15:1–EWRX21:1–
AC_230V_L2	mains supply 230V AC phase 2 ENF3:L2–EZX13:3–EZ119X1:DBZ26
AV_HT_AN	high tension actual value anode side 0V...+3.75V 1V ≙ 20kV measuring point EZ130X4
AV_HT_CA	high tension actual value cathode side 0V...+3.75V 1V ≙ 20kV measuring point EZ130X5
AV_HT	high tension actual value 0...+7.5V 1V ≙ 20kV measuring point EZ130X3
CAN_H	generator CAN high active EZ119X2:C3–EZ130X2:C3–EZ139X2:C3–EZ150X2:C3–EZX44:10–EZX45:10–EZX46:10– –C300X1:10–EZX51:3–EZX151:3–EZX52:7–EZX72– EWAX51:10–EWAX52:10–EWA100X2:C3– 0V/5V measuring point EZX72 part of: XRG bus
CAN_L	generator CAN low active EZ119X2:A3–EZ130X2:A3–EZ139X2:A3–EZ150X2:A3–EZX44:2–EZX45:2–EZX46:2– –C300X1:2–EZX51:2–EZX151:2– EZX52:2–EZX71– EWAX51:2–EWAX52:2–EWA100X2:A3– 0V/5V measuring point EZX71 part of: XRG bus
CM_EX_SW_1	common for exposure switch of release decade 1 EWA100X1:C5–EWAX1:10–

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CM_EX_SW_2	common for exposure switch of release decade 2 EWA100X1:C7–EWAX2:10–
CM_EX_SW_3	common for exposure switch of release decade 3 EWA100X1:C9–EWAX3:10–
CM_EX_SW_4	common for exposure switch of release decade 4 EWA100X1:C11–EWAX4:10–
CM_SW	common for radiation indication EZ150X1:C29–EZX1:6–
CM_TH	common for thermal sensor of tube housing EZ130X1:C12–EZX3:7– (generator basis 4512 104 70202/70601 only) EZ130X1:C12–EZX3:4–
CM_TH_SW	common for tube housing switch EZ130X1:C11–EZX3:4– (generator basis 4512 104 70202/70601 only) EZ130X1:C11–EZX3:7–
CTRL_X/	control X-ray request command, system level EZ139X1:A4–EZX23:4–EZX45:5–EWAX51:5–EWAX52:5–EWA100X2:C25– 0V/15V measuring point: EZX85 part of: system signal bus
CTRL_X_C/	control X-ray request command, internal generator level EZ119X2:C6–EZ130X2:C6–EZ139X2:C6–EZ150X2:C6–EZX52:8– 0V/5V measuring point EZX74 driven by CU, active, if STOP_X_C/ not active, immediately inactive if STOP_X_C/ active, controls all non AEC exposures with exposure timer or AEC exposures with DRC timer HTON high tension on command (internal generator command) resp. 20/21 signal (external = old world) part of: XS/XRG bus
CU_CT1_1	cooling unit contact 1_1 EZ150X1:A22–EZX2:6–
CU_CT1_2	cooling unit contact 1_2 EZ150X1:C22–EZX2:7–
CV1_GND	converter power part 1 ground EZ130X1:AC8–EZX24:8/21–EQ100X1:8/21
CV1_GND_OL	converter power part 1 ground overload (generator basis ≥ 4512 104 70203/70602) EZ130X1:A7–EZX24:20–EQ100X1:20
CV1_ID/	converter power part 1 identification EQ100X1:19–EZX24:19–EZ130X1:A6– open 5V, low active 0V

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CV1_OL/	converter power part 1 overload EQ100X1:7–EZX24:7–EZ130X1:C7– open +26V, low active 0V
CV1_TM	converter power part 1 temperature EQ100X1:6–EZX24:6–EZ130X1:C6– 0.3...3.5V, 85 °C...0 °C
CV2_GND	converter power part 2 ground EZ130X1:AC29–EZX34:8/21–E2Q100X1:8/21
CV2_GND_OL	converter power part 2 ground overload (generator basis ≥ 4512 104 70203/70602) EZ130X1:A28–EZX34:20–E2Q100X1:20
CV2_ID/	converter power part 2 identification E2Q100X1:19–EZX34:19–EZ130X1:A27– open 5V, low active 0V
CV2_OL	converter power part 2 overload E2Q100X1:7–EZX34:7–EZ130X1:C28– open +26V, low active 0V
CV2_TM	converter power part 2 temperature EZ130X1:C27–E2Q100X1:6–EZX34:6– 0.3...3.5V, 85 °C...0 °C
DR_BV_0V	dose rate (signal) reference of image intensifier EZX61:3–EZ139X2:C18– negative potential of II unit, 0V ± 50mV against generator ground differential signal with DR_BV_SG part of: dose rate control
DR_BV_SG	dose rate signal of image intensifier EZX61:8–EZ139X2:A18– positive potential, 0...10V differential signal with DR_BV_0V part of: dose rate control
DR_FQ_NG	dose rate signal (pulses) negative EZX61:6–EZ139X2:C20– 0.1 µR / pulse optocoupled interface, dose rate signal = pulsed frequency part of: dose rate control
DR_FQ_PO	dose rate signal (pulses) positive EZX61:1–EZ139X2:A20– 0.1 µR / pulse optocoupled interface, dose rate signal = pulsed frequency part of: dose rate control

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DR_TV_NT	dose rate of TV chain signal negative, fluoro regulation EZX61:4–EZ139X2:C19– ±12V minus polarity dual voltage differential signal +12V = 200% light, 0V = 100% light, –12V = 50% light part of: dose rate control
DR_TV_PT	dose rate of TV chain signal positive, fluoro regulation EZX61:9–EZ139X2:A19– ±12V positive polarity dual voltage differential signal –12V = 200% light, 0V = 100% light, +12V = 50% light part of: dose rate control
DS_BV_0V	dose (signal ramp) reference of image intensifier EZX61:2–EZ139X2C17– negative potential of II unit, 0V ±50mV against generator ground differential signal with DS_BV_SG part of: dose rate control
DS_BV_SG	dose signal ramp of image intensifier signal EZX61:7–EZ139X2:A17– 0...10V, polarity positive differential signal with DS_BV_0V part of: dose rate control
DS_MC_0V	dose (signal ramp) reference of selected measuring chamber EZ150X2:C16–EZ139X2:C16 negative potential of selected measuring chamber, 0V ±50mV against generator ground differential signal with DS_MC_SG
DS_MC_SG	dose signal ramp of selected measuring chamber EZ150X2:A16–EZ139X2:A16– 0...12V differential signal with DS_MC_0V
E_NG_CV1/2	E value converter DC supply negative converter 1: EQ100X1:5–EZX24:5–EZ130X1:C5– converter 2: E2Q100X1:5–EZX34:5–EZ130X1:C26 (future releases) 0...–12V ≙ 0...–375V
E_PO_CV1/2	E value converter DC supply positive converter 1: EQ100X1:18–EZX24:18–EZ130X1:A5– converter 2: E2Q100X1:18–EZX34:18–EZ130X1:A26 (future releases) 0...+12V ≙ 0...+375V
EN_X/	enable X-ray, system level EZ139X1:C2–EZX10:1/3–EZX23:15–EZX45:11–EZX46:11–C300X1:11– –EWAX51:11–EWAX52:11–EWA100X2:C26– measuring point: EZX82, EZ139X9 part of: signal bus 0V/15V low active

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EN_X_C/	enable X-ray, internal generator level EZ119X2:C7–EZ130X1:A9–EZ130X1:A30–EZ130X2:C7–EZ139X2:C7–EZ150X2:C7–EZX52:9–EZX76– 0V/5V low active measuring point EZX76 driven by CU if EN_X/ active (low) part of: XS/XRG bus
CV1 EN/ CV2 EN/	converter 1/2 enable converter 1: EZ130X1:A9–EZX24:22–EQ100X1:22– converter 2: EZ130X1:A30–EZX34:22–E2Q100X1:22–
EX_ON	exposure on EWA100X2:A9–EWAX14:7– part of: exon old world
FD_C_CH1	central field measuring chamber 1 EZ150X1:C4–EZX21:12– 15V, R_i = 220 Ω
FD_C_CH2	central field measuring chamber 2 EZ150X1:A4–EZX22:12– 15V, R_i = 220 Ω
FD_C_CH3	central field measuring chamber 3 EZ150X1:C10–EZX31:12– 15V, R_i = 220 Ω
FD_C_CH4	central field measuring chamber 4 EZ150X1:A10–EZX32:12– 15V, R_i = 220 Ω
FD_C_CH5	central field measuring chamber 5 EZ150X1:C16–EZX41:12– 15V, R_i = 220 Ω
FD_L_CH1	left field measuring chamber 1 EZ150X1:C3–EZX21:11– 15V, R_i = 220 Ω
FD_L_CH2	left field measuring chamber 2 EZ150X1:A3–EZX22:11– 15V, R_i = 220 Ω
FD_L_CH3	left field measuring chamber 3 EZ150X1:C9–EZX31:11– 15V, R_i = 220 Ω
FD_L_CH4	left field measuring chamber 4 EZ150X1:A9–EZX32:11 15V, R_i = 220 Ω

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FD_L_CH5	left field measuring chamber 5 EZ150X1:C15–EZX41:11– 15V, R_i = 220 Ω
FD_R_CH1	right field measuring chamber 1 EZ150X1:C5–EZX21:3 15V, R_i = 220 Ω
FD_R_CH2	right field measuring chamber 2 EZ150X1:A5–EZX22:3– 15V, R_i = 220 Ω
FD_R_CH3	right field measuring chamber 3 EZ150X1:C11–EZX31:3– 15V, R_i = 220 Ω
FD_R_CH4	right field measuring chamber 4 EZ150X1:A11–EZX32:3– 15V, R_i = 220 Ω
FD_R_CH5	right field measuring chamber 5 EZ150X1:C17–EZX41:3– 15V, R_i = 220 Ω
FI_TF1_1	filament transformer 1 line 1 EZ119X1:DBZ4–EZX12:1–EG106X15:1– max. 300Veff or ± 150V against ground, 100...20kHz
FI_TF1_2	filament transformer 1 line 2 EZ119X1:DBZ6–EZX12:2–EG106X15:2– max 300Veff or ± 150V against ground, 100...20kHz
FI_TF2_1	filament transformer 2 line 1 EZ119X1:DBZ8–EZX12:4–EG106X15:4 max. 300Veff or ± 150V against ground, 100...20kHz
FI_TF2_2	filament transformer 2 line 2 EZ119X1:DBZ10–EZX12:5–EG106X15:5– max. 300Veff or ± 150V against ground, 100...20kHz
GND	
GND_15V	ground (+15V) for desk handswitch C300X3:1/2/6–
GNDC S_CAN_GND	CAN bus ground EZ139X1:C17–EZX42:3/6–EZX43:3/6–EZX44:9– part of: system CAN

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GNDS PO_0V	signal bus ground EZ139X1:AC1–EZX23:1/14–EZX44:15–EZX45:15–EWAX51:15–EWAX52:15– part of: signal bus negative
HT_AN	high tension anode side actual value EG100X14:2–EZX35:2–EZ130X1:C17– 0...+10V ≙ 0...+100 kV
HT_AN_GND	high tension anode side ground EG100X14:10–EZX35:10–EZ130X1:A17– 0V
HT_CA	high tension cathode side actual value EG100X14:1–EZX35:1–EZ130X1:C16– 0...–10V ≙ 0...–100kV
HT_CA_GND	high tension cathode side ground EG100X14:9–EZX35:9—EZ130X1:A16 0V
I1_1 I1_1/	IGBT1 power part 1 EQ100 = 4512 108 05882 IGBT1 power part 1 EQ100 ≥ 4512 108 08621 * EZ130X1:C1–EZX24:1–EQ100X1:1–
I1_1/ I1_1	IGBT1 power part 1 EQ100 = 4512 108 05882 IGBT1 power part 1 EQ100 ≥ 4512 108 08621 * EZ130X1:A1–EZX24:14–EQ100X1:14– value: on = 3.7V off = 1.2V against ground * = X10 measuring point EQ100 R25 end to X1 * EQ100 X6
I1_2 I1_2/	IGBT2 power part 1 EQ100 = 4512 108 05882 IGBT2 power part 1 EQ100 ≥ 4512 108 08621 * EZ130X1:C2–EZX24:2–EQ100X1:2–
I1_2/ I1_2	IGBT2 power part 1 EQ100 = 4512 108 05882 IGBT2 power part 1 EQ100 ≥ 4512 108 08621 * EZ130X1:A2–EZX24:15–EQ100X1:15– value: on = 3.7V off = 1.2V against ground * = X10 measuring point EQ100 R27 end to X1 * EQ100 X7
I1_3 I1_3/	IGBT3 power part 1 EQ100 = 4512 108 05882 IGBT3 power part 1 EQ100 ≥ 4512 108 08621 * EZ130X1:C3–EZX24:3–EQ100X1:3–
I1_3/ I1_3	IGBT3 power part 1 EQ100 = 4512 108 05882 IGBT3 power part 1 EQ100 ≥ 4512 108 08621 * EZ130X1:A3–EZX24:16–EQ100X1:16– value: on = 3.7V off = 1.2V against ground * = X10 measuring point EQ100 R29 end to X1 * EQ100 X8

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I1_4	IGBT4 power part 1 EQ100 = 4512 108 05882
I1_4/	IGBT4 power part 1 EQ100 ≥ 4512 108 08621 *
	EZ130X1:C4–EZX24:4–EQ100X1:4–

I1_4/	IGBT4 power part 1 EQ100 = 4512 108 05882
I1_4	IGBT4 power part 1 EQ100 ≥ 4512 108 08621 *
	EZ130X1:A4–EZX24:17–EQ100X1:17–
	value: on = 3.7V off = 1.2V against ground * = X10
	measuring point EQ100 R31 end to X1 * EQ100 X9

I2_1	IGBT1 power part 2 E2Q100 = 4512 108 05882
I2_1/	IGBT1 power part 2 E2Q100 ≥ 4512 108 08621 *
	EZ130X1:C22–EZX34:1–E2Q100X1:1–

I2_1/	IGBT1 power part 2 E2Q100 = 4512 108 05882
I2_1	IGBT1 power part 2 E2Q100 ≥ 4512 108 08621 *
	EZ130X1:A22–EZX34:14–E2Q100X1:14
	value: on = 3.7V off = 1.2V against ground * = X10
	measuring point EQ100 R25 end to X1 * E2Q100 X6

I2_2	IGBT2 power part 2 E2Q100 = 4512 108 05882
I2_2/	IGBT2 power part 2 E2Q100 ≥ 4512 108 08621 *
	EZ130X1:C23–EZX34:2–E2Q100X1:2–

I2_2/	IGBT2 power part 2 E2Q100 = 4512 108 05882
I2_2	IGBT2 power part 2 E2Q100 ≥ 4512 108 08621 *
	EZ130X1:A23–EZX34:15–E2Q100X1:15–
	value: on = 3.7V off = 1.2V against ground * = X10
	measuring point EQ100 R27 end to X1 * E2Q100 X7

I2_3	IGBT3 power part 2 E2Q100 = 4512 108 05882
I2_3/	IGBT3 power part 2 E2Q100 ≥ 4512 108 08621 *
	EZ130X1:C24–EZX34:3–E2Q100X1:3–

I2_3/	IGBT3 power part 2 E2Q100 = 4512 108 05882
I2_3	IGBT3 power part 2 E2Q100 ≥ 4512 108 08621 *
	EZ130X1:A24–EZX34:16–E2Q100X1:16–
	value: on = 3.7V off = 1.2V against ground * = X10
	measuring point EQ100 R29 end to X1 * E2Q100 X8

I2_4	IGBT4 power part 2 E2Q100 = 4512 108 05882
I2_4/	IGBT4 power part 2 E2Q100 ≥ 4512 108 08621 *
	EZ130X1:C25–EZX34:4–E2Q100X1:4–

I2_4/	IGBT4 power part 2 E2Q100 = 4512 108 05882
I2_4	IGBT4 power part 2 E2Q100 ≥ 4512 108 08621 *
	EZ130X1:A25–EZX34:17–E2Q100X1:17–
	value: on = 3.7V off = 1.2V against ground * = X10
	measuring point EQ100 R31 end to X1 * E2Q100 X9

IT_0V	emitter 0V exposure on signal
	EWA100X2:C9–EWAX14:9–
	part of: exon old world

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Iu	stator current U of Low Speed Rotor Control low speed measuring point EYAX22
Iw	stator current W of Low Speed Rotor Control low speed measuring point EYAX21
MN_EM_OF	mains power emergency off EZX4:1–EZX47:6–EN100X1:6–
MN_ON	mains on C300X1:6–EZX46:6–EZX47:2–EN100X1:2–EZX44:14–
NG_15V	– 15 V supply Vee EZ102X2:DBZ24–EZ119X2:AC12–EZ130X2:AC12–EZ139X2:AC12–EZ150C2:AC12–EZX21/22/31/32/41:6–EZX35:15– EZX51:8–EZX151:8–EG100X14:15– EZX31:6–EZX32 –14.5V ..... –15.5V
NR_PR_X/	not ready preparing for X-ray (low active) EZ139X1:A3–EZX23:3–EZX45:4–EZX46:4–C300X1:4– –EWAX51:4–EWAX52:4–EWA100X2:A24– driven by CU measuring point: EZX83 part of: signal bus
PO_12V	+ 12 V supply EN100X1:1–EZX47:1–EZX46:7–C300X1:7–
PO_15V	+ 15 V supply Vdd EZ102X2:DBZ22–EZ119X2:AC11–EZ130X2:AC11–EZ139X2:AC11 –EZ150X2:AC11–EZX2:8/9–EZX35:7–EZX44:12/13–EZX46:5 –EZX51:7–EG100X14:7–C300X1:5 –EZX21/22/31/32/41:5 only generator basis 4512 104 70202/70601 –EZX151:7 generator basis ≥ 4512 104 70203/70602 +14.5V ..... +15.5V
PO_15/40V	+ 15 V or + 40 V supply for measuring chamber EZ150X1:A20–EZX21/22/31/32/41:5
PO_26V	+ 26 V supply EZ102X2:DBZ28–EZ119X2:AC14–EZ130X2:AC14–EZ139X2:AC14 –EZ150X2:AC14–EZX1:5–EZX2:3–EZX3:9–EZX11:1–EZX17:1–EZX18:1–EWAX1:4– –EWAX2:4–EWAX3:4–EWAX4:4–EWAX41:1–EWAX23:9–EWAX24:5–EWA100X2:A14–EWA100X2:C14– –EQ100X2:1–E2Q100X2:1–
PO_26V_1	+ 26 V supply optional EZ102X2:DBZ32–EZX19:1–EZX20:1– EZX8:1 generator basis ≥ 4512 104 70203/70602
PO_26V_RE	+ 26 V supply reverse EWAW11–EWAW12–EWAX1/2/3/4:4–EWAX42:1– if generator and system release voltage are of the same polarity PO_26V_RE = +26V, if not PO_26_RE = 0V against –24V
PO_26V_SW	+ 26 V supply switched EZ102X1:D32–EZX7:1–EM1 generator basis ≥ 4512 104 70203/70602

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PO_400V	+ 400 V supply measuring chamber EZ150X1:AC1–EZX21/22/31/32/41:1– +400V , Ri=100k
PO_5V	+ 5 V supply Vcc EZ102X2:DBZ2/4/6–EZ119X2:AC1/2–EZ130X2:AC1/2–EZ139X2:AC1/2–EZ150X2:AC1/2–EZX46:9–C300X1:9– EZX51:4/5/6–EZX151:4/5/6 +4.74V ..... +5.25V
PO_V	signal bus supply EZX23:13/25–EZX44:5–EZX45:7–EWAX51/52:7– EWA100X2:AC27–EZ139X1:AC6– Vsgn part of: signal bus
POWERFAIL/	power fail signal of power supply EZ102X1:D30–EZ139X1:A10–
PW_ON_NG	DC supply relay power on negative EZ130X1:A15–EZX47:9–EN100X1:9– 0V/+15V, low active
PW_ON_PO	DC supply relay power on positive EZ130X1:C15–EZX47:4–EN100X1:4– +15V
RC_ON/	rotor control on EZ150X1:A25–EZX51:1–
RC_RD/	rotor control ready EYAX1:9(low speed)–EXZ51:9–EZ150X1:C25– measuring point EYAX25 low speed rotor control
RC_ST_2/	rotor control stator 2 EZ150X1:A26–EZX16:1(low speed)–EY100X3:1(high speed)–EWGX14:1
RC_ST_3/	rotor control stator 3 EZ150X1:C26–EZX16:2(low speed)–EY100X3:2(high speed)–EWGX14:2–EWGX15:1–E1WGX14:1
RD_MN_ON	ready mains power on C300X1:14–EZX46:14–EZX47:7–EN100X1:7–
RD_PR_X NR_PR_X/	ready preparing for X–ray or not ready preparing for X-ray (low active) EZ139X1:A3–EZX23:3–EZX45:4–EZX46:4–C300X1:4– –EWAX51:4–EWAX52:4–EWA100X2:A24– driven by CU measuring point: EZX83 part of: signal bus
REL_CH1	release (reset integrator) chamber 1 EZ150X1:C6–EZX21:4–
REL_CH2	release (reset integrator) chamber 2 EZ150X1:A6–EZX22:4–

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REL_CH3	release (reset integrator) chamber 3 EZ150X1:C12–EZX31:4–
REL_CH4	release (reset integrator) chamber 4 EZ150X1:A12–EZX32:4–
REL_CH5	release (reset integrator) chamber 5 EZ150X1:C18–EZX41:4–
RESET_C/	system RESET command EZ130X2:A6–EZ119X2:A6–EZ139X2:A6–EZ150X2:A6–EZX45:3–EZX46:3–C300X1:3– –EZX51:10–EZX52:3–EZX73–EWAX51:3–EWAX52:3–EWA100X1:A6– 0V/5V measuring point EZX73 driven by CU, active (low) if: EZ139 S1 activated, RESET_SW/ active, threatening power supply drop in, watchdog alarm, switch on (button), resets FU's drop in, part of: XS/XRG bus
RESET_SW/	signal bus reset, generator reset EZX23:2–EZX44:6–EZ139X1:A2– low active $\tau \geq 200$ms (τ = 8.41 WP) resets CU measuring point: EZX81 part of: signal bus
RF_0V_CH1	0V reference value measuring chamber 1 EZX21:8–EZ150X1:C8– differential signal with SIGN_CH1
RF_0V_CH2	0V reference value measuring chamber 2 EZX22:8–EZ150X1:A8– differential signal with SIGN_CH2
RF_0V_CH3	0V reference value measuring chamber 3 EZX31:8–EZ150X1:C14– differential signal with SIGN_CH3
RF_0V_CH4	0V reference value measuring chamber 4 EZX32:8–EZ150X1:A14– differential signal with SIGN_CH4
RF_0V_CH5	0V reference value measuring chamber 5 EZX41:8–EZ150X1:C20– differential signal with SIGN_CH5
RG_DV_1	registration device 1 selected EWA100X1:C4–EWAX1:5–
RG_DV_2	registration device 2 selected EWA100X1:A7–EWAX2:5–

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RG_DV_3	registration device 3 selected EWA100X1:A9–EWAX3:5–
RG_DV_4	registration device 4 selected EWA100X1:A11–EWAX4:5–
RM_DR_0V	room door contact 0V EZ150X1:C28–EZX1:10–
RM_DR_CT	room door contact EZX1:8–EZ150X1:A28–
RQ_SN_X/	request synchronization of X–ray EZX23:16–EZX45:12–EZX46:12–C300X1:12–EZ139X1:C3––EWAX51:12–EWAX52:12–EWA100X2:A25– measuring point: EZX84 part of: signal bus
RQ_XG_EX	request X-ray generator for exposure EWAX1/2/3/4:1–EWA100X1:A3
RQ_XG_FL	request X-ray generator for fluoroscopy EWAX1/2/3/4:6–EWA100X1:A5
RQ_XG_PR_1	request X-ray generator for preparation EWAX1:3–EWA100X1:A4–
RQ_XG_PR_2	request X-ray generator for preparation EWAX2:3–EWA100X1:C6–
RQ_XG_PR_3	request X-ray generator for preparation EWAX3:3–EWA100X1:C8–
RQ_XG_PR_4	request X-ray generator for preparation EWAX4:3–EWA100X1:C10–
RX_CAN_1	system CAN 1 optional EZX44:3–EZ139X1:C15– part of: system CAN
RX_CAN_2	system CAN 2 optional EZX43:1–EZX44:11–
S_CAN_L (CAN_N)	system CAN low active EZ139X1:C16–EZX42:2–EZX43:2– part of: system CAN
S_CAN_H (CAN_P)	system CAN high active EZ139X1:A16–EZX42:7–EZX43:7– part of: system CAN

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S_CAN_PO	system CAN supply EZX42:9–EZX43:9–EZX44:4–EZ139X1:A17– Vcan part of: system CAN
SI_PH_ID SI_PH/	single phase identifier EN100X1:5–EZX47:5–EZ130X1:C14–
SIGN_CH1	signal ramp of measuring chamber 1 EZX21:7–EZ150X1:C7– 0...12V (24V out of range possible) differential signal with FR_0V_CH1
SIGN_CH2	signal ramp of measuring chamber 2 EZX22:7–EZ150X1:A7– 0...12V (24V out of range possible) differential signal with RF_0V_CH2
SIGN_CH3	signal ramp of measuring chamber 3 EZX31:7–EZ150X1:C13– 0...12V (24V out of range possible) differential signal with RF_0V_CH3
SIGN_CH4	signal ramp of measuring chamber 4 EZX32:7–EZ150X1:A13– 0...12V (24V out of range possible) differential signal with RF_0V_CH4
SIGN_CH5	signal ramp of measuring chamber 5 EZX41:7–EZ150X1:C19– 0...12V (24V out of range possible) differential signal with RF_0V_CH5
SL_CO_1	select correction 1 (thickness) EWA100X1:A32–EWAX24:8–
SL_CO_2	select correction 2 (thickness) EWA100X1:C32–EWAX24:9–
SL_PG_1	select ext APRT program 1 EWA100X1:A28–EWAX23:1–
SL_PG_2	select ext APRT program 2 EWA100X1:C28–EWAX23:2–
SL_PG_3	select ext APRT program 3 EWA100X1:A29–EWAX23:3–
SL_PG_4	select ext APRT program 4 EWA100X1:C29–EWAX23:4–

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SL_PG_5	select ext APRT program 5 EWA100X1:A30–EWAX23:5–
SL_PG_6	select ext APRT program 6 EWA100X1:C30–EWAX23:6–
SL_PG_7	select ext APRT program 7 EWA100X1:A31–EWAX23:7–
SL_PG_8	select ext APRT program 8 EWA100X1:C31–EWAX23:8–
SL_TO_TM_1	select tomo time 1 EWAX21:1–EWA100X1:A24–
SL_TO_TM_2	select tomo time 2 EWAX21:2–EWA100X1:C24–
SL_TO_TM_3	select tomo time 3 EWAX21:3–EWA100X1:A25–
SL_TO_TM_4	select tomo time 4 EWAX21:4–EWA100X1:C25–
SL_TO_TM_5	select tomo time 5 EWAX21:5–EWA100X1:A26–
SL_TO_TM_6	select tomo time 6 EWAX21:6–EWA100X1:C26–
SL_TO_TM_7	select tomo time 7 EWAX21:7–EWA100X1:A27–
SL_TO_TM_8	select tomo time 8 EWAX21:8–EWA100X1:C27–
SL_XG_TO	select X-ray generator for tomography EWAX11:3–EWAX12:3–EWA100X1:C18–
STOP_X_C/	stop X-ray command, X-ray off from FU EZ119X2:A7–EZ130X2:A7–EZ150X2:A7–EZX52:4–EZ139X2:A7– 0V/5V measuring point EZX75 inactivates CTRL_X_C/ EXOF exposure off command part of: XS/XRG bus
STU	stator line U EYAX2:2(low speed)–EY100X6:2/EY100X46:2(high speed)–EWGK11/K12:1 part of: low/high speed rotor control

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STV	stator line V = common EYAX2:3(low speed)–EY100X6:3/EY100X47:1(high speed)–EWGK11/K12:3 part of: low/high speed rotor control
STW	stator line W EYAX2:4(low speed)–EY100X6:4/EY100X47:2(high speed)–EWGK11/K12:5 part of: low/high speed rotor control
SW_BU_1	switch bucky EWAX11:10–EWA100C1:C19– part of: bucky ready contact
SW_BU_2	switch bucky 2 (EWA or EWB) or 4 (EWB) EWAX12:10–EWA100X1:A21– –EWB100X1:A21–EWBX12:10– part of: bucky ready contact
SW_SF_CF_1	switch side field to central field bucky measuring chamber EWAX11:1–EWA100X1:A18–
SW_SF_CF_2	switch side field to central field bucky measuring chamber 2 (EWA or EWB) or 4 (EWB) EWAX12:1–EWA100X1:A20–
SW_TO_1	switch tomography 1 EWAX11:5–EWA100X1:A19– part of: tomo ready contact
SW_TO_2	switch tomography 2 EWAX12:5–EWA100X1:C20– part of: tomo ready contact
SW_UN_EX	radiation indication EZ150X1:A29–EZX1:4–
TB_2/	tube 2 selected EZ130X1:A13–EZX11:2–EWGX11:2 0V/15V, low active
TB_2_RT	tube 2 selection check EWGX11:3–EZX11:3–EZ130X1:A10 0V/5V, low active
TB_3/	tube 3 selected EZ130X1:C13–EZX11:5–EWGX11:5–EWGX12:2 0V/15V, low active
TB_3_RT	tube 3 selection check E2WGX11:3–E1WGX12:3–E1WGX11:6–EZX11:6–EZ130X1:C10– 0V/5V, low active
TB_CU_FR_NG	tube current frequency negative EG100X14:14–EZX35:14–EZ119X1:BZ32– –15V against ground

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TB_CU_FR_PO	tube current frequency positive EG100X16:6–EZX35:6–EZ119X1:BZ30– 15V against ground, frequency: 1 kHz ≙ 2 mA, 0...1500mA 500kHz/A
TH_OL	tube housing overload EZX3:6–EZ130X1:A12– (generator basis 4512 104 70202/70601 only) EZX3:3–EZ130X1:A12– 0...5V
TH_OL_SW/	tube housing overload switch EZX3:3–EZ130X1:A11– (generator basis 4512 104 70202/70601 only) EZX3:6–EZ130X1:A11– 0V/26V, low active
TO_MO_PG	tomo mode programmed EWA100X1:A17–EWAX22:9–
TO_PG_1	tomo program 1 EWA100X1:A13–EWAX22:1–
TO_PG_2	tomo program 2 EWA100X1:C13–EWAX22:2–
TO_PG_3	tomo program 3 EWA100X1:A14–EWAX22:3–
TO_PG_4	tomo program 4 EWA100X1:C14–EWAX22:4–
TO_PG_5	tomo program 5 EWA100X1:A15–EWAX22:5–
TO_PG_6	tomo program 6 EWA100X1:C15–EWAX22:6–
TO_PG_7	tomo program 7 EWA100X1:A16–EWAX22:7–
TO_PG_8	tomo program 8 EWA100X1:C16–EWAX22:8–
TO_PG_SL	tomo program selected EWA100X1:C17–EWAX22:10–
TP_HT_GND	temperature high tension tank ground EZ130X1:A19–EZX35:12–EG100X14:4–
TP_HT_SG	temperature signal high tension tank EG100X14:12–EZX35:4–EZ130X1:C19– 0...5V +25 °C(12kΩ)...+100 °C(950 Ω)

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V15C S_CAN_PO	system CAN supply EZX42:9–EZX43:9–EZX44:4–EZ139X1:A17– Vcan part of: system CAN
V15S PO_V	signal bus supply EZX23:13/25–EZX44:5–EZX45:7–EWAX51/52:7– EWA100X2:AC27–EZ139X1:AC6– Vsgn part of: signal bus
X_ACT/	signal bus X-ray active EZ139X1:A5–EZX23:5–EZX45:6–EWAX51/52:6–EWA100X2:C24– driven by CU, X_ACT_S/ status dependent, old: EXON signal measuring point: EZX86 part of: signal bus 0V/15V
X_ACT_S/	X-Ray active signal, kV > 75% nominal value or 'fluoroscopy technique' high tension on EZ119X2:A8–EZ130X2:A8–EZ139X2:A8–EZ150X2:A8–EZX52:5– 0V/5V measuring point EZX77 HTON (high tension on) or FLON (fluoroscopy high tension on) signal part of: XS/XRG bus, controls X_ACT/ status
XG_RD_EX_1	X-ray generator ready for exposure request EWA100X1:C3–EWAX1:2–
XG_RD_EX_2	X-ray generator ready for exposure request EWA100X1:A6–EWAX2:2–
XG_RD_EX_3	X-ray generator ready for exposure request EWA100X1:A8–EWAX3:2–
XG_RD_EX_4	X-ray generator ready for exposure request EWA100X1:A10–EWAX4:2–

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REPLACEMENT

TEXT

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1. H.V. generator

The H.V. generator is a traceable item and is therefore labelled as follows:

- type number
- serial number
- manufacturer
- HHS certification

} combined label

- code number

H.V. generators have a serial number which has the following meaning:

Example:

96 01 005

Meaning:

96 = year of manufacture, e.g. 1996
01 = power class, e.g. 50 kW, 1 tube
005 = consecutive number

Power classes:

01 = 50 kW, 1 tube
02 = 50 kW, 2 tubes
03 = 65/80 kW, 1 tube
04 = 65/80 kW, 2 tubes

With the H.V. generator for replacement a separate label will be delivered. This must be affixed to the label bracket on the top left corner of the generator cabinet. See drawing 2Z–1 Labelling.

The new type number, code number and serial number must be entered on the master card for the generator.

Please, send a copy of the corrected master card as FAX to:

Philips Medical Systems
DMC Hamburg, Germany
Department XGT40
FAX No. +49 40 5078 1247

2. Operating panel

The operating panel is a traceable item and is therefore labelled as follows:

- type number
- serial number
- manufacturer
- HHS certification

} combined label

- code number

The new type number, code number and serial number must be entered on the master card for the generator.

Please, send a copy of the corrected master card to the address mentioned above.

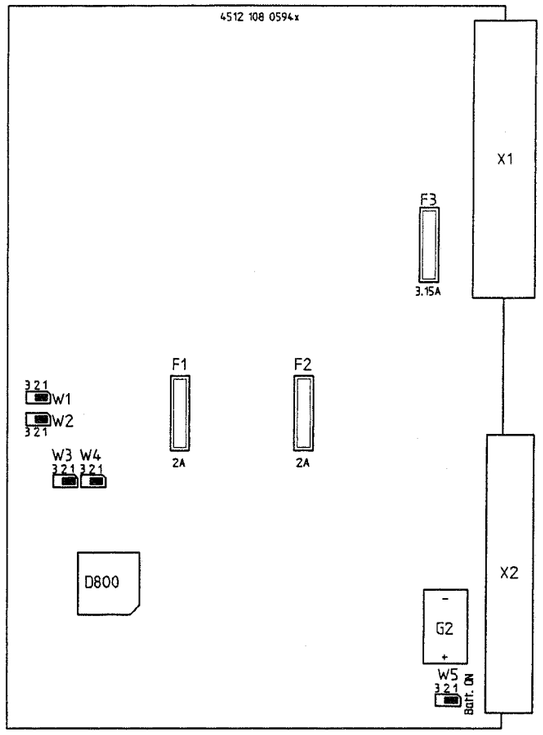
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3. Printed–circuit boards

PCB	HW programming	SW programming via XRGScope	Adaptation of tube	Remarks
EZ Back panel	see Z2–5.1/2/3			– To attend to: X4, X10, X42, X44, X52 – Tube supervision on X3: connection changed from 3–4 to 6–7 from level 4 onwards.
EZ 102 Low voltage supply				
EZ 119 mA control	see 5Z–1	Tube data set	x	
EZ 130 kV control	see 5Z–1			
EZ 139 CU	see 5Z–1	– Restore complete – Program date and time		Note the exposure counter data previously.
EZ 150 Basic interface	see 5Z–1	AMPLIMAT sensitivity according to jumper W4		Jumper W1 ... W4 from level 4 onwards
EN 100 Power ON circuit				
EG 100 Measuring circuit	–	–	–	Exchange not allowed at time. Exchange the whole tank.
EWA Back panel	see Z1–15.1 – address W1...W3 – ground W11...W13			
EWA 102 Universal I/O interface	see 5Z–2			
EY 100 Rotor control high speed	see 5Z–2			
EYA 100 Rotor control low speed				
C 300 Desk CPU	see 5Z–2			

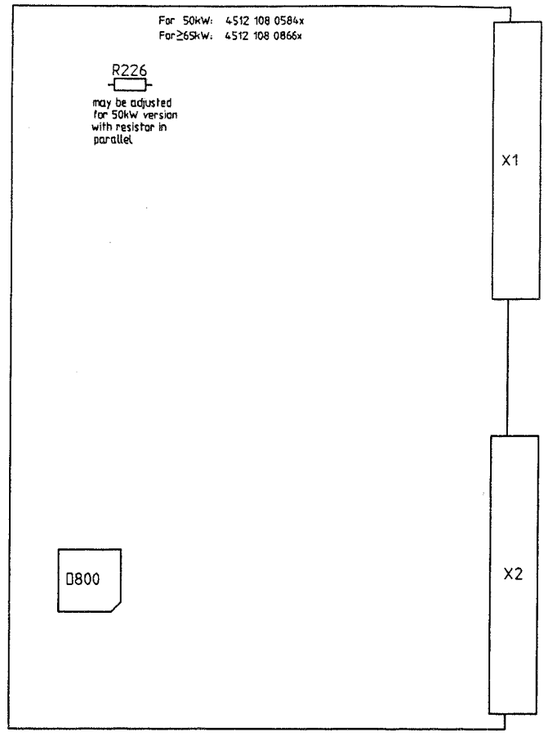
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EZ 119 mA control



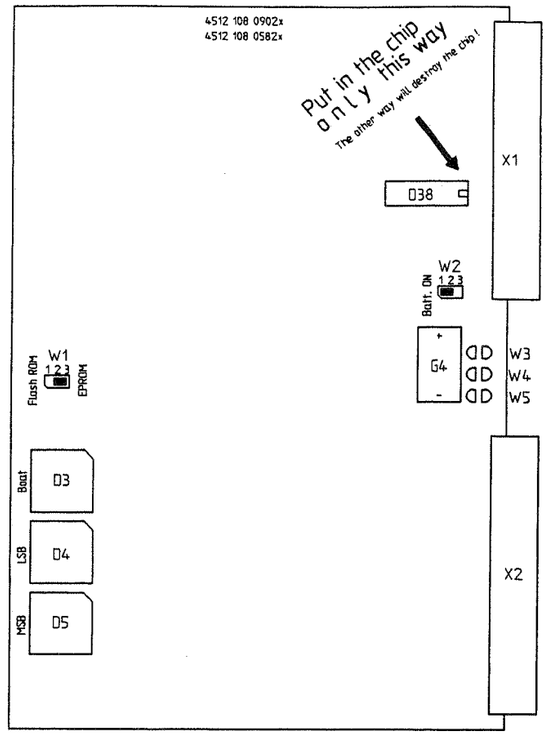
D800 = 4512 113 2020$\frac{4}{5}$ (4512 114 2020$\frac{4}{5}$)

EZ 130 kV control (50kW)/ kV control 2 (≥65kW)



D800 = 4512 113 20112 (4512 114 20112)

EZ 139 Central unit



D3 = 4512 113 20721 (4512 114 20721)

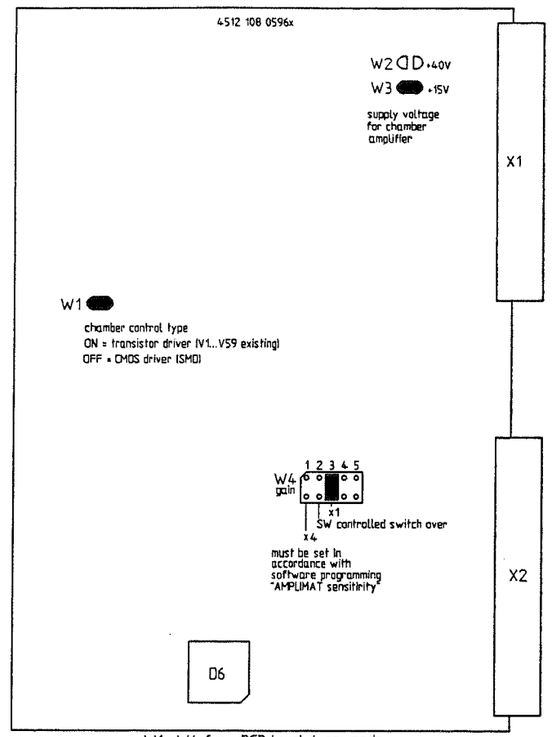
D38 = function key, marked with s/n of the generator

		Rel. 2.1	Rel. 2.2
D4	=	4512 113 18025	18026
D5	=	4512 113 18035	18036

9890 000 02503 (4512 114 20821)

9890 000 02503 (4512 114 20822)

EZ 150 Basic interface



W1...W4 from PCB level 4 onwards

D6 = 4512 113 20301 (4512 114 20301)

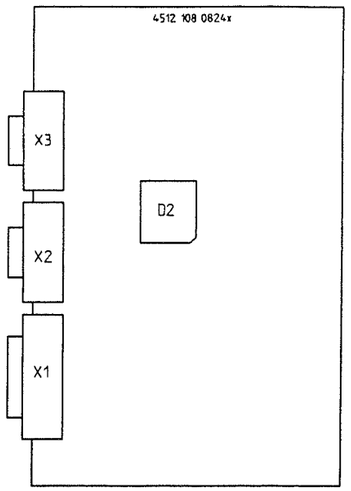
A1/A3 96-06-03 Schr.
ub0636

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PCB programming
central rack EZ

Operating desk C

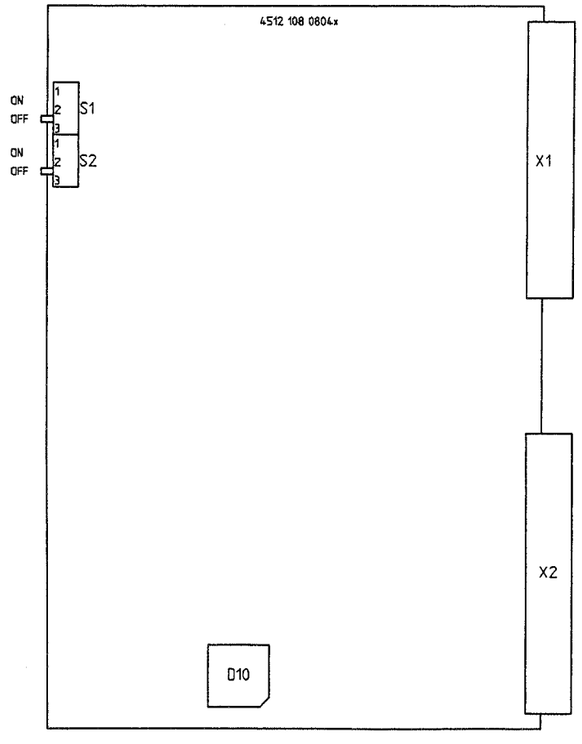
C 300 CPU



D2 = 4512 113 20511/2 (4512 114 20511/2)

Adapter decade cable WA, 1WA, 2WA

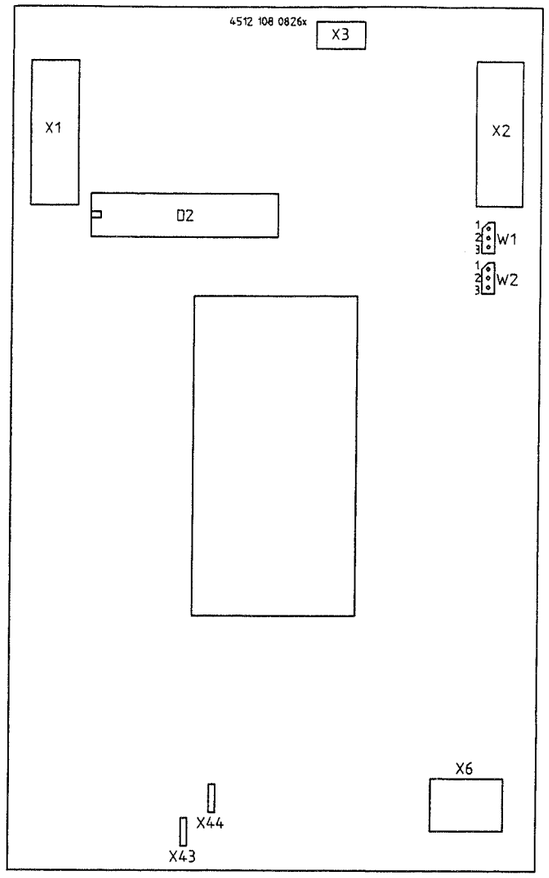
WA 102 Universal I/O interface



D10 = 4512 113 20601 (4512 114 20601)

High speed rotor control Y 9890 000 02211

Y 100 Roco HS

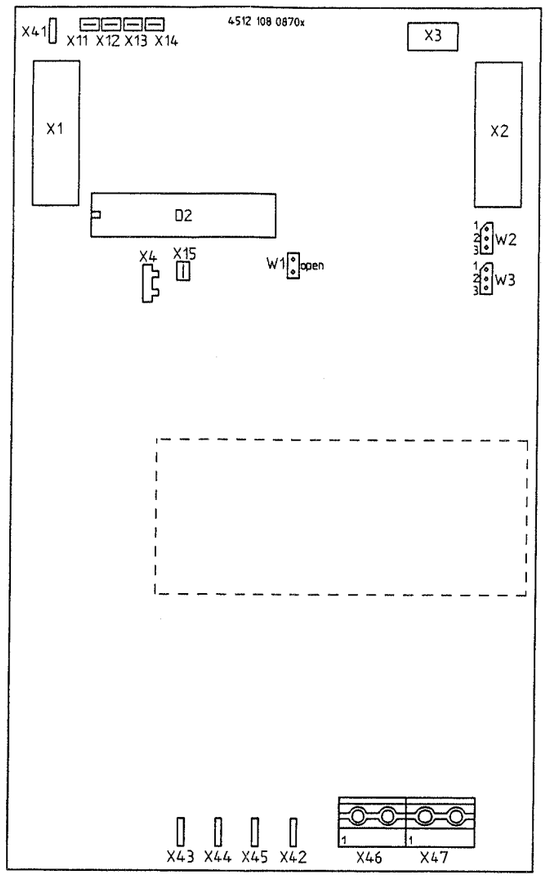


Coding	Rotor control 1st	2nd	3rd
W1	1 2 3		
W2	1 2 3		

D2 = 4512 113 20401 (4512 114 20401)
compatible: 4512 113 22301 (4512 114 22301)

High speed rotor control Y 9890 000 02212

Y 100 Roco HS



Coding	Rotor control 1st	2nd
W2	1 2 3	
W3	1 2 3	

D2 = 4512 113 22301 (4512 114 22301)

A1/A3 96-06-05 Schr.
ub0647

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ADJUSTMENTS

TEXT

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1. Area exposure product calculation (option) 6–1

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1.2. Correction of the specific yield 6–2

1.3. Correction of the filter values 6–4

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1. Area exposure product calculation (option)

Special tools:
- calibrated dosemeter, e.g. DALI with measuring cell 77334 or PMX3
- 1 mm lead plate

The following parameters are relevant to calculation:
- SID (Source Image Distance)
- diaphragm aperture
- added filters
- specific yield of tube
- mAs product
- number of exposures

SID, diaphragm aperture and type of filters are supplied by the diagnostic unit, where they are also adjusted.

In the generator default values are given for the specific yield of a tube and filter correction.

These default values can be found as reference files on floppy disk in order to recreate the original settings if need be.

Reference files:

ref_yiel.tdl	specific yield of tube
ref_2al.tdl	filter 2 mm Al
ref_01cu.tdl	filter 1 mm Al + 0.1 mm Cu
ref_02cu.tdl	filter 1 mm Al + 0.2 mm Cu

The specific yield curve relates to tungsten anodes and 2.5 mm primary filters.

Display on the desk is in: [cGycm^2].

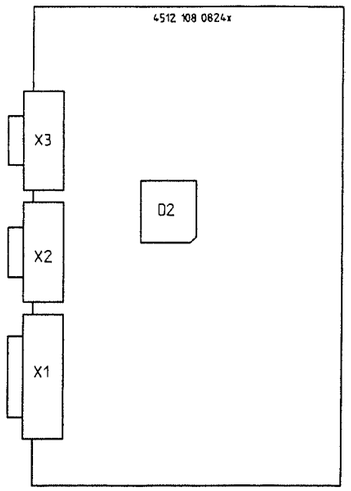
1.1. Checking the default adjustment

- Place the lead plate and the measuring cell of the measuring instrument on the table in the central radiation beam. The purpose of the lead plate is to reduce radiation scatter of the table top. Without the plate the test result would be approximately 10% higher using a table top made, for example, from resin bonded paper.
- Perform the following settings:
  - 1 m between the focus and the measuring cell (=SMD)
  - free cassette technique
  - kV–mAs–s technique
  - 10 mAs
  - 0.1 s
  - collimation 10 x 10 cm at the height of the measuring cell
  - no filter

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Operating desk C

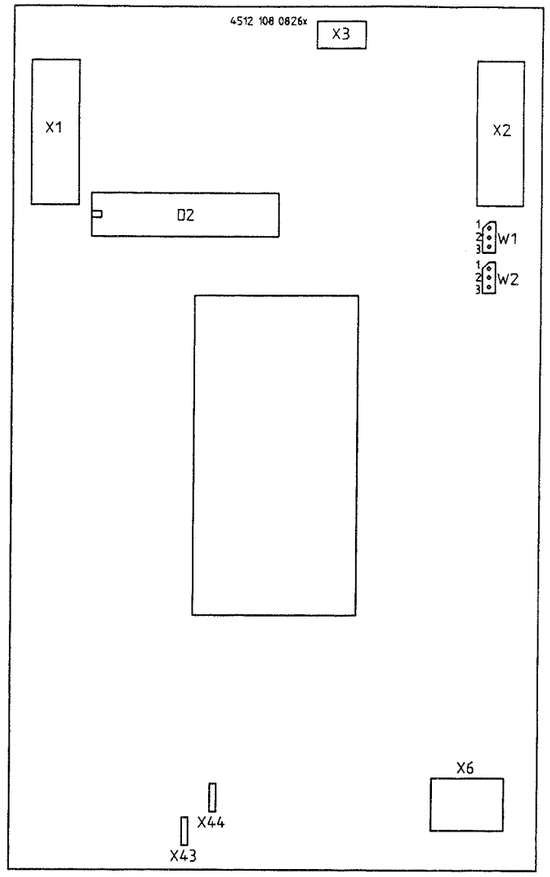
C 300 CPU



D2 = 4512 113 20511 (4512 114 20511)

High speed rotor control Y 9890 000 02211

Y 100 Roco HS

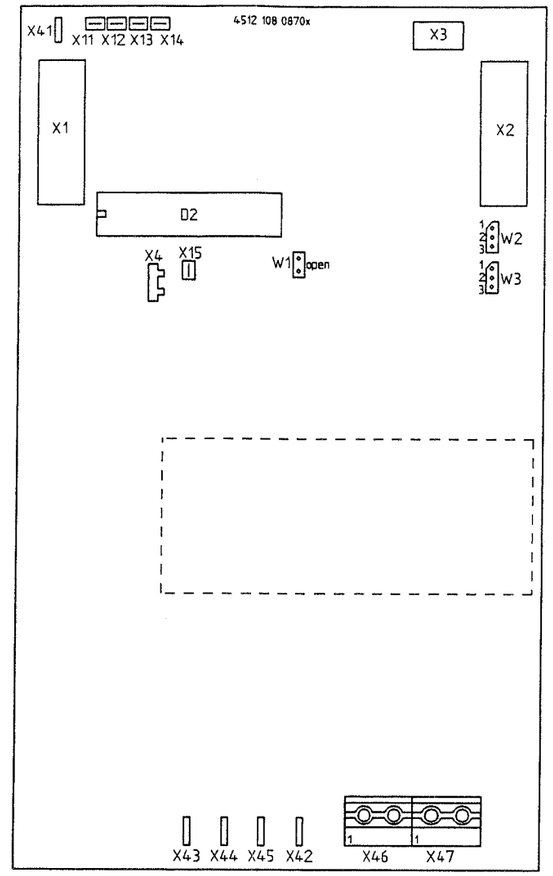


Coding	Rotor control 1st	2nd	3rd
W1	1 2 3		
W2	1 2 3		

D2 = 4512 113 20401 (4512 114 20401)
compatible: 4512 113 22301 (4512 114 22301)

High speed rotor control Y 9890 000 02212

Y 100 Roco HS

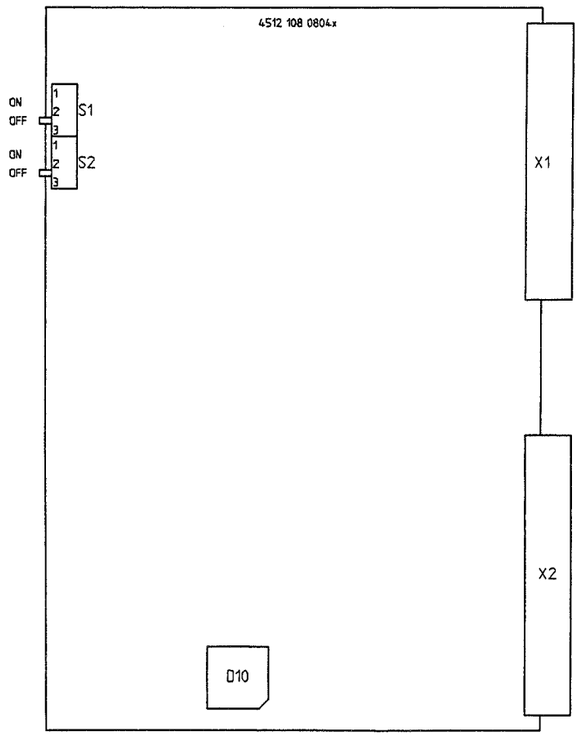


Coding	Rotor control 1st	2nd
W2	1 2 3	
W3	1 2 3	

D2 = 4512 113 22301 (4512 114 22301)

Adapter decade cable WA, 1WA, 2WA

WA 102 Universal I/O interface



D10 = 4512 113 20601 (4512 114 20601)

A1/A3 96-06-05 Schr.
ub0647

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ADJUSTMENTS

TEXT

Contents 6–0.1

1. **Area exposure product calculation (option)** 6–1

1.1. Correction of the default adjustment 6–1

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1.3. Correction of the filter values 6–4

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1. Area exposure product calculation (option)

Special tools:
- calibrated dosemeter, e.g. DALI with measuring cell 77334 or PMX3
- 1 mm lead plate

The following parameters are relevant to calculation:
- SID (Source Image Distance)
- diaphragm aperture
- added filters
- specific yield of tube
- mAs product
- number of exposures

SID, diaphragm aperture and type of filters are supplied by the diagnostic unit, where they are also adjusted.

In the generator default values are given for the specific yield of a tube and filter correction.

These default values can be found as reference files on floppy disk in order to recreate the original settings if need be.

Reference files:

ref_yiel.tdl	specific yield of tube
ref_2al.tdl	filter 2 mm Al
ref_01cu.tdl	filter 1 mm Al + 0.1 mm Cu
ref_02cu.tdl	filter 1 mm Al + 0.2 mm Cu

The specific yield curve relates to tungsten anodes and 2.5 mm primary filters.

Display on the desk is in: [cGycm^2].

1.1. Checking the default adjustment

- Place the lead plate and the measuring cell of the measuring instrument on the table in the central radiation beam. The purpose of the lead plate is to reduce radiation scatter of the table top. Without the plate the test result would be approximately 10% higher using a table top made, for example, from resin bonded paper.
- Perform the following settings:
  - 1 m between the focus and the measuring cell (=SMD)
  - free cassette technique
  - kV–mAs–s technique
  - 10 mAs
  - 0.1 s
  - collimation 10 x 10 cm at the height of the measuring cell
  - no filter

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- Determine area dose at the following kV settings and compare it with the respective value displayed on the desk.

	50 kV	80 (81) kV	120 (117) kV
displayed product	..... $cGycm^2$	..... $cGycm^2$	..... $cGycm^2$
measured dose	..... cGy	..... cGy	..... cGy
calculated product	..... $cGycm^2$	..... $cGycm^2$	..... $cGycm^2$
difference in %	.....	.....	.....

Example:

- displayed area exposure product: 8.8 $cGycm^2$
- measured dose: 890 µGy = 0.089 cGy
- calculated area exposure product: measured dose × exposed area
  = 0.089 cGy × 100 cm^2
  = 8.9 $cGycm^2$
- difference in %: $= \frac{8.9-8.8}{8.9} \times 100 = 1.12\ \%$

- If there are any deviations of over 5% it is recommended that the yield curve be corrected in accordance with the procedure described in 1.2.

1.2. Correction of the specific yield

Prerequisite:

Test setup and settings in accordance with section 1.1.:

- 1 m between the focus and the measuring cell (=SMD)
- free cassette technique
- kV–mAs–s technique
- 10 mAs
- 0.1 s
- collimation 10 x 10 cm at the height of the measuring cell
- no filter

Principle:

For each kV specified a dose measurement is taken under the same conditions. If the distance between the focus and the measuring cell deviates from 1 m, all the dose values must be corrected with the square of distance (unit of measurement is [m]). Dividing the dose values by the mAs product set gives the respective current yield.

Procedure:

- Measure dose at each kV checkpoint and use it to calculate specific yield.

  The values determined must be greater at higher kVs settings and produce a characteristic with a slight curve on the graph. If considerable fluctuations are detected, the measurements must be repeated at the points in question.

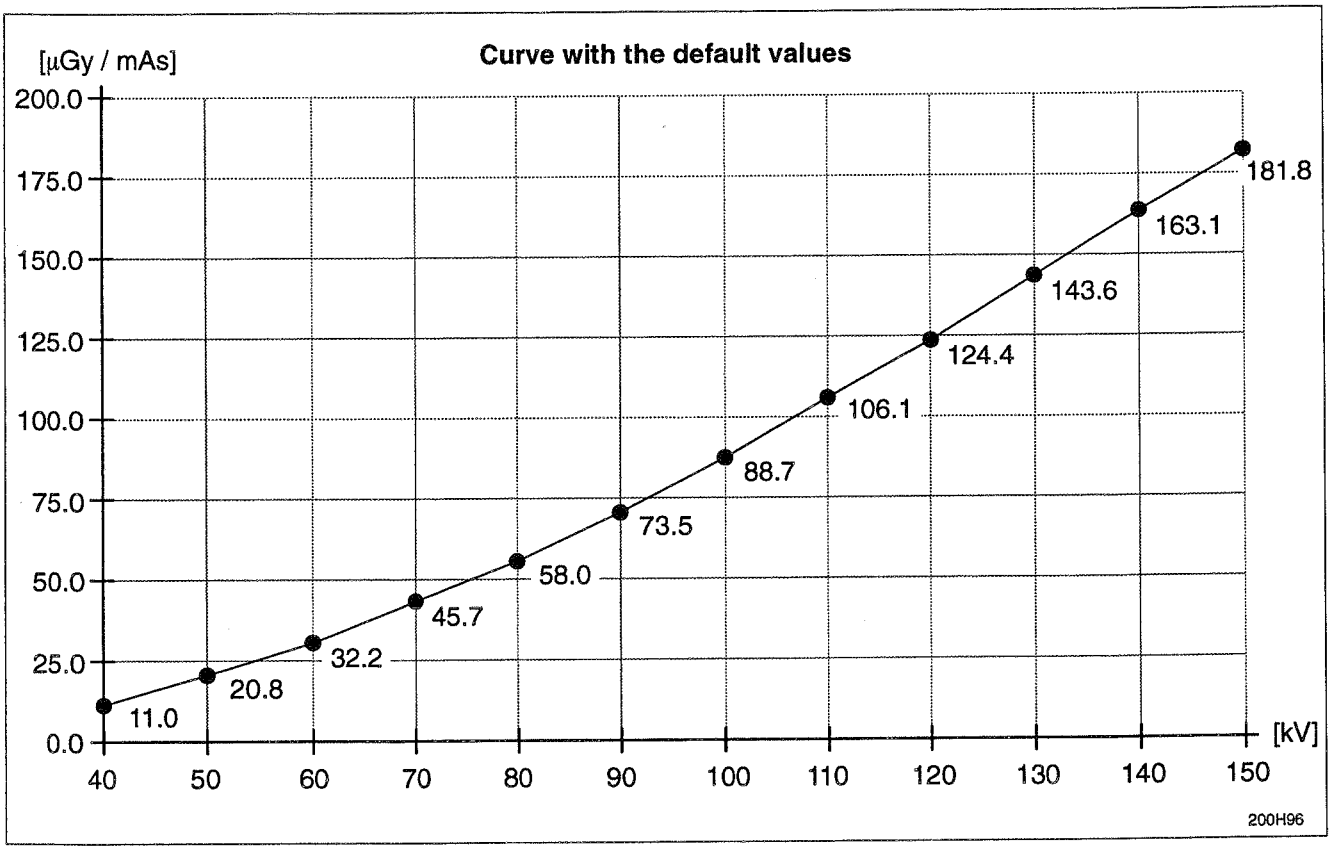
  Range: 0.00 ... 400.00 µGy/mAs

  The values can only be stored in the generator if they are within the range specified and rise uniformly with kV.

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Specific yield

kV checkpoint	40	50	60	70	80	90	100	110	120	130	140	150
default yield [µGy/mAs]	11.0	20.8	32.2	45.7	58.0	73.5	88.7	106.1	124.4	143.6	163.1	181.8
measured dose [µGy]												
distance^{2}factor	If the distance focus – measuring cell (= SMD) differs from 1 m correct the dose with this factor, distance^2 factor = (SMD [m] / 1 m)^2 = ... e.g. = 1.44 for a SMD of 1.2 m											
corrected dose [µGy]												
specific yield [µGy/mAs]	calculate: specific yield = corrected dose / 10 mAs											



- Correct the default values of the specific yield for all the kV checkpoints using the menu ***"Adjust/ Area Exposure Product/ Specific Yield of Tube 1...3"*** with the factor determined and save with <Transmit>.
- Save the specific yield curve with the SAVE function of XRGSCOPE (F3 key) on the backup disk.

  Recommended file name: act_yiel.tdl

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1.3. Correction of the filter values

Prerequisite:

Test setup and settings in accordance with section 1.1.

- 1 m between the focus and the measuring cell (=SMD)
- free cassette technique
- kV–mAs–s technique
- 10 mAs
- 0.1 s
- collimation 10 x 10 cm at the height of the measuring cell
- no filter

Principle:

At otherwise identical settings the dose is determined for the kV values specified with and without filter. The ratio of dose values with/without filter produces the respective current correction factor.

Procedure:

- Accept measured dose values (not the corrected ones!) for the respective kV checkpoints from yield measurement or measure them again if any changes have been made to the test–setup or settings.
- Move the filter to be checked into the radiation beam.
- Measure dose at each kV checkpoint and enter it in the respective table.

  Note

  The 40 kV range is not used in practice so it does not have to be corrected.
  If in the lower kV range the considerably reduced dose can no longer be measured or read perfectly, at that point a higher mAs product must be selected. Then the repeat measurement must be performed without filter.

- Using the ratio between dose with and without filter determine the respective correction factor.

  The values determined must be greater at higher kVs settings and produce a characteristic with a slight curve on the graph. If considerable fluctuations are detected, the measurements must be repeated at the points in question.

  Range: 0.000 ... 1.000
  The values can only be stored in the generator if they are within the range specified and rise uniformly with kV.

- Perform the procedure for each selectable filter type.

Filter correction – 2 mm Al

kV–checkpoint	~~40~~	50	70	100	150
default factor	~~0.39~~	0.47	0.56	0.66	0.75
measured dose [µGy] without filter					
measured dose [µGy] with filter					
new factor	new factor = dose with filter / dose without filter				

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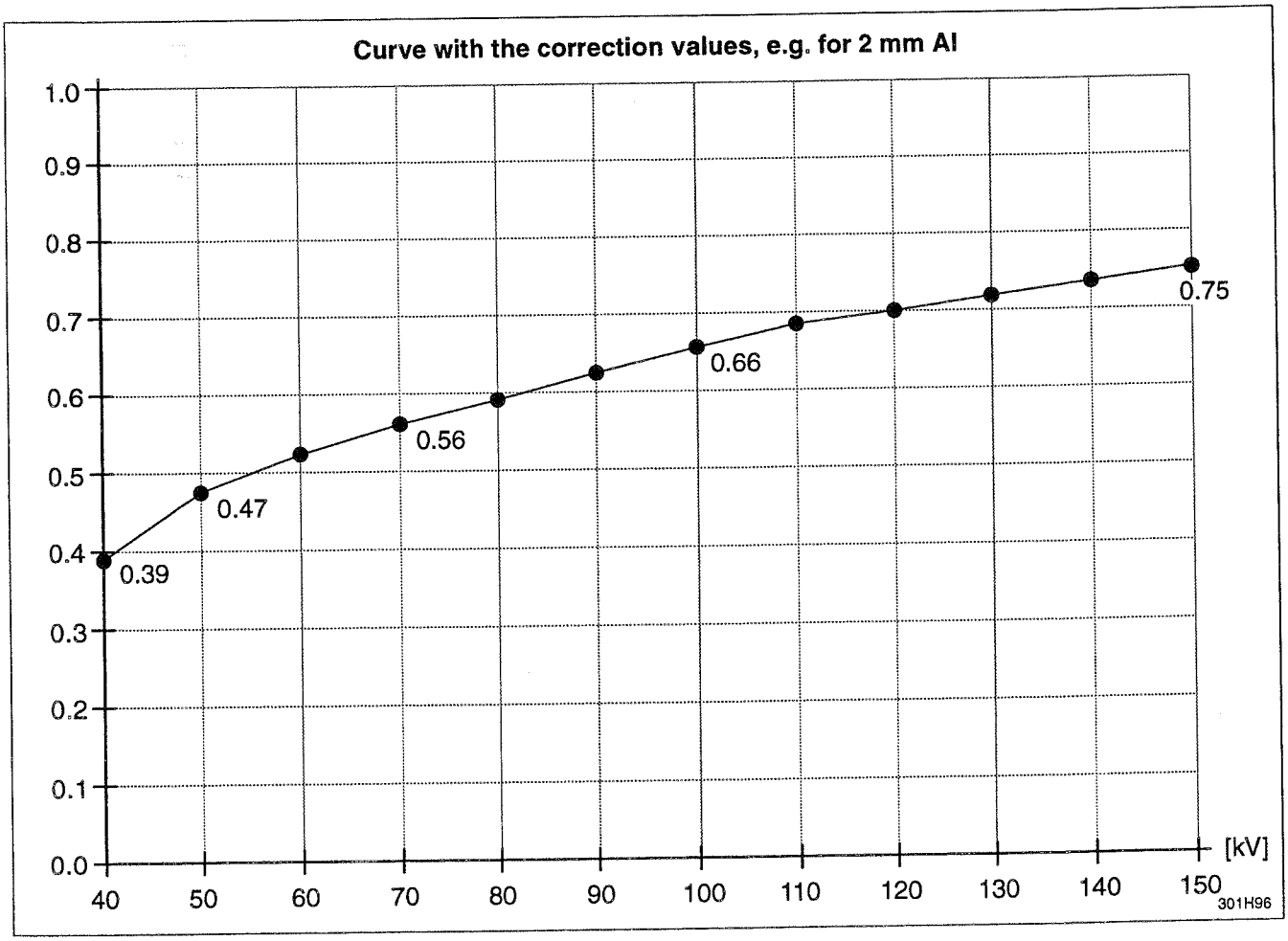
Filter correction – 1 mm Al + 0.1 Cu

kV–checkpoint	~~40~~	50	70	100	150
default factor	~~0.17~~	0.25	0.37	0.5	0.65
measured dose [µGy] without filter	X				
measured dose [µGy] with filter	X				
new factor	new factor = dose with filter / dose without filter				
	X				

Filter correction – 1 mm Al + 0.2 Cu

kV–checkpoint	~~40~~	50	70	100	150
default factor	~~0.064~~	0.123	0.23	0.37	0.53
measured dose [µGy] without filter	X				
measured dose [µGy] with filter	X				
new factor	new factor = dose with filter / dose without filter				
	X				

Curve with the correction values, e.g. for 2 mm Al



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- Read out the default values of the filter tables for each kV checkpoint, correct with the factor determined and write back into the generator with <Transmit>.

  Menu ***"Adjust/ Area Exposure Product/ Add Filter Correction Tables/...***

  ... 2 mm AL"

  ... 1 mm AL+0.1mm CU"

  ... 1 mm AL+0.2mm CU"

- Save the specific correction tables with the SAVE function of XRGSCOPE (F3 key) on the backup disk.

  Recommended file names:

  act_2al.tdl filter 2 mm Al

  act_01cu.tdl – filter 1 mm Al + 0.1 mm Cu

  act_02cu.tdl filter 1 mm Al + 0.2 mm Cu

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ACCEPTANCE

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2. Test equipment 7–1

3. Setup 7–1

4. Test 7–2

5. Exposure Counter 7–3

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1. Preface

The national rules for accepting a X–ray system are very different. Therefore in the following is given an example for checking the generator in the U.S.A.

OPTIMUS generators are factory–calibrated and checked for compliance with the parameter readout tolerances as stated in the relevant Operator's Manuals.

Provided these generators are installed and set to work in accordance with the Installation Manuals only the following limited field compliance testing is required.

2. Test equipment

- Keithley voltage divider model No. 35080 with filter packs 32867C, 5C, 9C or equivalent.
- Oscilloscope (storage)
- Digital mA, mAs meter.

Notes

Do not start test until generator has been switched on for at least one hour.

Direct (invasive) kVp measurements on OPTIMUS generators with HV divider tanks normally available to the field service organization are not permitted.

Measurements of kV using instruments other than the Keithley instrument may lead to larger measuring tolerances. The causes are to be found in the specific frequency response and transient response of each test instrument.

3. Setup

- Switch off generator and also switch off main disconnect breaker to system.
- Connect digital mA meter as per instructions in the relevant Service Manual.
- Set up the Keithley voltage divider complete with the appropriate filter as per Keithley Instructions Manual No. 3294 OIM.
- Connect the oscilloscope to the Keithley divider.

Note

Make sure that the oscilloscope has been calibrated with the aid of the Keithley divider as described in the Keithley Instructions Manual before starting any testing (par. 3.6. Internal calibration).

- Calculate rejection limits based on the exposure parameter "Specification Limits" shown in the table below.

  The "Specification Limits" are based on the actual tolerances as listed in the generator Operator's Manuals. These "Specification Limits" must be restricted to include the actual measuring instrument error. See also section 6, par. 3.1. of "Comprehensive Compliance Testing Manual" No. 4535 800 2034. regarding how to calculate rejection limits.

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4. Test

- Switch the system on.
- Measure the mains voltage on ENF1.

  Reference voltage: Mains voltage programmed ±10%

  Actual values: L1 – L2: V

  L1 – L3: V

  L2 – L3: V

- Select the largest focus.
- Release exposures according to the table below and compare the values measured with the reference values.

Technique	Parameter	Reference range	Measured value	Corrected value
3–knob technique	81 kV ±5% ±1 kV	76 ... 86 kV	..... kV	—
	250 mA ±5% ±0.5 mA	237 ... 263 mA	..... mA	..... mA
	100 ms ±5% ±0.5 ms	94.5 ... 105.5 ms	..... ms	—
2–knob technique	125 kV ±5% ±1 kV	118 ... 132 kV	..... kV	—
	80 mAs ±3% ±0.5 mAs	77.1 ... 82.9 mAs	..... mAs	..... mAs

Owing to an offset current in the measuring circuit of the HV generator the measured values for mA/mAs must be adjusted using the following formulas:

$$I_{corrected}\ [mA] = I_{measured}\ [mA] - \frac{U\ [kV]}{R_{calc.}\ [M\Omega]} \qquad \text{Offset} \approx 0.2 \ldots 0.75\ mA$$

$$Q_{corrected}\ [mAs] = Q_{measured}\ [mAs] - \frac{U\ [kV] \times t\ [s]}{R_{calc.}\ [M\Omega]} - \underbrace{\frac{4.55\ [nF] \times U\ [kV]}{1000}}_{\text{Cable charge for 20 m HV cable}}$$

$R_{calc.}$ = calculated measuring circuit resistance. Typical value: ≈ 200 MΩ
Is read out via service menu *"FU_mA/ Fault find/ Read I_e corrections"*.
Focus assignment:

Focus 1	=	tube 1, large focus
2	=	tube 1, small focus
3	=	tube 2, large focus
4	=	tube 2, small focus
5	=	tube 3, large focus
6	=	tube 3, small focus

t = exposure time according to desk display.

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5. Exposure Counter

Before handing over the generator to the customer, read the Exposure Counter via the *"Accept/Inspect/**Exposure Counter**"* menu and record the figure in the table.

The count cannot be changed, so it is recommended that also whenever the tube or the CU PCB is being replaced, or whenever the entire CU PCB programming is being deleted, the count be recorded in the system logbook and/or in the following table.

Tube 1	Tube 2	Tube 3	Remarks

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O P T I M U S GENERATOR
Release 2.1

This HELP-manual is in the order of the typical 'programming' or 'setting to work procedure' of the Optimus Release 2.1 INSTALLATION instruction (chapter 2).

Optimus (XRG90) → Program

- **Date and Time** ok (ok = no further explanation)

- **Mains data**
  - U_mains_nominal [V], available values = 380/400/440/480V
    default value = 400V
  - Ri_mains [mΩ] range of mains impedance = 0...500 mΩ
    default values: 50kW = 200mΩ
    65kW = 100mΩ
    80kW = 100mΩ

  It is important to select (U) and type in (Ri) the true values. The calculation of the kV_control for the duty cycle to drive the IGBT's is based on that.

Reduction table:			**380V**	**400V**	**440V**	**480V**
Ri for	<	300mΩ	50kW	50kW	50kW	50kW
Optimus	<	350mΩ	40kW	50kW	50kW	50kW
50kW	<	400mΩ	30kW	40kW	50kW	50kW
Single	<	450mΩ	30kW	30kW	40kW	40kW
Converter	<	500mΩ	30kW	30kW	30kW	30kW
Ri for	<	150mΩ	100kW	100kW	100kW	100kW
Optimus	<	200mΩ	80kW	80kW	100kW	100kW
65/80kW	<	250mΩ	65kW	65kW	80kW	80kW
Double	<	300mΩ	50kW	65kW	65kW	80kW
Converter	<	350mΩ	40kW	50kW	50kW	65kW
	<	400mΩ	30kW	40kW	50kW	50kW
	<	450mΩ	30kW	30kW	40kW	40kW
	<	500mΩ	30kW	30kW	30kW	30kW

The max kW is programmed in the function key EZ139 D38
(depending on the customer order, see STAMMKARTE on front kV power unit).

- **Tubes**
  - **Tube 1**...3
    - **Tube 1**...3 **Data Set**

After 35 sec of 'Reading' the screen Load Data from Disc comes up, offering the default TUBE_R2.TDL.
With <OK> Availabe Tubes (Rel.2 Format) gives a selection of all available tubes in air cooled housings ROT350 or water cooled housings ROT351.
If XRGSCOPE is used from the harddisc the path will automatically be taken into account.
After tube selection the PC screen will come up with 'Transmitting' and displays the 'Percent transmitted' of the file.

!! In case of a single focus tube like RO30: APR's loaded to a RGDV with this tube connected should only be programmed on the **large** focus (use APR_manager).

- **Tube 1**...3 **Speed Selection** range = 3000...9000 rpm

  - Exposure rotation [RPM]: the speed for every technique
  - Fast Exposure rotation [RPM]: is taken from the tube data on
  - Fluoroscopy rotation [RPM]: the installation disc

  !! **all** stators have to be connected as an SRO tube !!

  Under certain circumstances it might happen, that a problem occurs in a combination of High Speed Rotor Control and any **RO**talix tube. 3000 rpm is the default value for RO tubes. If PREP is activated the tube will be accelerated. The problem now might be that the tube will not be braked, no further activation is possible. In this case the RO speed has to be increased to 3500 rpm or 3600 rpm (max!). Then reset the generator and test accelation and braking.

- **Tube Limits** (only **[value]** fields can be modified)

  Tube: 1 ... 3

  Max. Tube Voltage Limit [kV]: range: **[20...150]** kV

  The value must be adapted to the max kV of the tube (see tube label). If a tube arcs during adaptation the max kV value can be reduced (or repeat the break in procedure). After adaptation the reduced value is the max value which can be selected on the control desk, even if the value can be increased thereafter in this field. The reduced value appears in 'Adapted To [kV]:'.
  If a tube has been adapted with a higher kV than it should be used for (e.g. veterinary surgions max 100kV) the limit must be programmed in this data field.

  Focus: small, middle, large

  The middle focus is a third physical filament in a tube (not yet available), it is **not** the VARIO focus.

  Min. Tube Voltage Limit [kV]: range: **[20...150]** kV

  All regular tubes of the installation tube file has a default min kV of 40 kV. This value can only be modified in a range > 40kV.

  Adapted To [kV]: gives the max available kV value on the control desk.

  If this value must be increased, first the 'Max Tube Voltage Limit [kV]:' must be increased. Then the tube has be adapted thereafter to have the higher kV available for application.

  Min. Tube Current Limit [mA]: range: **[0.1 ... 2000]** mA

  0.1 mA is the lowest current of the Optimus. The smallest mA value one can select on the control desk for radiographical exposures is 1 mA.

  Max. Tube Current Limit [mA]: range: **[0.1 ... 2000]** mA

  The max mA value is automatically limited by the tube type **and** the generator version:
  50 kW max = 650 mA 65 kW max = 900 mA 80 kW max = 1100 mA

  The max mA value is initially set by the tube file, it will be adapted to the individual focus limits during adaptation, max mA table can be seen in 'Select Unit' → 'FU_mA' → 'Programming'.

!! If there is any applicational reason to modify the max mA value it is possible, but it will influence all registration devices linked to this tube and might lead to problems, if additional reductions of the emission current and tube power are programmed in the individual 'APR Data Set's and/or in 'RGDV Data Set B'.

- **Capacitance Tube Connection** - formula = see INSTALLATION 9.3.4

  - **Tube 1** ... 3 **Capacitance on Tube Connection [nF]:**

    range = 2.000nF - 10.000nF

- **Tube Operating Modes**

  - **intermediate boost:**

    enable = double boost mode (default)

    Active, if emission current is in a range of [Ie max] ... [Ie max - 20%]
    Automatically inactive, if emission current < [Ie max - 20%].

    If 'single step' has been programmed at 'Exposure switch type' in 'Data Set A' the generator switches automatically to 'disable' = single boost mode

    disable = single boost mode

    (explanation see functional unit FU_mA chapter 3 FAULTFIND)

  - **rotation prolongation after prep:** !! Only possible with HIGH SPEED rotor control !!

    disable = Tube stops immediately after let go of the PREP handswitch (default)

    enable = Once started with PREP, the tube keeps on rotating for 30 seconds if no exposure has been switched.
    The tube stops
    - if finally an exposure has been switched
      or
    - if the exposure parameters have been changed or
      if another APR has been selected during the free run of the tube.

    Should be 'enabled' at childrens hospitals and A&E rooms.

- **Disable Tube**

  - If a tube has to be removed use this function. All registration devices (RGDV) linked to a deleted tube are not available anymore after generator cold/warmstart.
    This function **must** be used before a single filament tube is programmed on a 'tube number' where there has been a two filament tube before (to tell FU_mA to switch off the non used filament circuit, if the single focus tube is selected).

  - !! In combination with a Bucky Controller: If a tube has been disabled and this was the only one, there will be no access to the generator with the PC after generator reset. To get access remove system CAN connection EZX42/43 to the Bucky Controller before reset. It takes two minutes (timeout) after switch on or warmstart, the generator will send error message 00CQ (bucky is not responding) to the PC screen.

- **Registration Devices**
  - **RGDV 1** ... 8
    - **RGDV 1**...8 **Data Set A**
      - **Room:** **Room 1**...3 ok see INSTALLATION 4.4.1
      - **Tube:** **None** RGDV not availabe, can be used to disable a tube selection without erasing the tube data in the mA_control
        Tube 1...3 a tube must be programmed to activate a RGDV
      - **Release circuit number:** **Circuit 1** ... 4
        - one out of four release circuits of a 'Release circuit adaptation unit' 1WA, 2WA, 1WB, 2WB
          (e.g. WA: 1 = EWAX1 2 = EWAX2 3 = EWAX3 4 = EWAX4)
        - ignore in case of a 'Bucky controller' or 'Thoravision'
        - ignore, if 'none' is programmed for a 'Release circuit adaptation unit'
        - 'RGDV' number and 'Release circuit number' must **not** be the same, (e.g. all 8 RGDV's might be programmed to one release circuit only)
      - **Enable handswitch at release circuit:**
        no = release with the desk handswitch only
        yes = - release via the programmed decade only ('Release circuit number')
        - should not be programmed in combination with Bucky Controller via CAN
      - **Syncmaster present (e.g. grid contact):**
        yes = has to be programmed in case of
        - Release circuit adaptation units (WA/WB):
          - grid synchronisation (20-21) decade pins 1-2
          - dto. tomo release (exposure request of layer angle)
          - cassette present interlock free cassette
        - Bucky (+Tomo) Controller via CAN EZX43 for grid sync and tomo release synchronization

        no = in case of free cassette RGDV's via release decades or Bucky Controller (then no link has to be inserted in any of the four release decades pin 1-2 of the adaptation units WA/WB)
      - **Exposure switch type:**
        double step = individual PREP and EXPOSURE request with the desk handswitch or via the release decades WA/WB
        single step = instant EXPOSURE request with PREP activation only, released from
        - the desk handswith or
        - the release decades WA/WB or
        - the PREP switch S2 of the 'Release circuit adaptation unit' WA/WB

        does **not** work without 'Release circuit adaptation unit'

!! If 'intermediate boost' mode has been 'enable'd to switch on double boost mode, it will automatically been switchd off if 'single step' is programmed.

- **Bucky format density correction (6% steps):** range = - 8 ... + 8
see !!!! page 17

  - correction during collimation, input at WAX11/12 pin 1-2, sidefields active when contact closed, centre field only when open
  - with GALILEO collimator via Bucky Controller

- **Cone density correction (6% steps):** range = - 8 ... + 8
see !!!! page 17

  only in case of cone collimation with WB adaptor (not yet available) and future RF systems via system CAN

- **Dose measurement input:** none = no **AEC/AECF/TDC** function available
  EZX21 \
  EZX22 \
  EZX31 >backpanel input plugs
  EZX32 /
  EZX41 /

  AEC = **A**utomatic **E**xposure **C**ontrol ≡ Amplimat falling load
  AECF = **AEC F**ixed current = Amplimat kV-mA
  TDC = **T**omo **D**ensity **C**ontrol (option)

- **No brake after exposure end:**

  no = instant brake after exposure end

  yes = more than one exposure possible with one PREP

  Has to be 'yes' for tomo in combination with a 'Release decade adaptation unit' 1WA/2WA and in case of 'Bucky TH with TOMO via Bucky Controller'
  Preparation must be active until the tomo stand is back to the 0-position.

- **Release delay (automatic techniques):**

  enable **Must** be set for AEC / AECF / TDC techniques to switch on kV not before the dose integrator has been reset and the offset of the chamber signal line has been measured by Dose Rate Control.
  Must also be enabled if an Amplimat stand without grid sync is connected.
  Automatically disabled if a non AEC technique is selected.

  disable instant kV with EXPOSURE command

- **Mounted radiographical controller:**

  none **!! none !! must** be programmed if any 'Release circuit adaptation unit' is programmed

  Bucky controller 1 = Bucky'94 via system CAN EZX43
  Bucky controller 2 = (dto.), but no yet available
  Thoravision = not yet available

- **Release circuit adaptation unit:** (old world adaptor)

  none = to be programmed in case of free cassette if no cassette present interlock is necessary

  !! none !! **must** be programmed if any 'Mounted radiographical controller' is programmed

  1WA = Bucky / Tomo
  2WA = Bucky / Tomo
  1WB = Scopo / Fluoro / Angio \\\\ not yet
  2WB = dto. //// available

- **Mounted tomo extension:** only, if a 'Release circuit adaptation unit' option exists

  none = ok

  !! none !! **must** be programmed if any 'Mounted radiographical controller' is programmed

  1WA ** see RGDV Data Set B
  2WA ** 'Used for tomo'

- **RGDV 1...8 Data Set B**

  - **Used for tomo:**

    no = ok

    yes =
    - has additionally to be set if any 'Mounted tomo extension' was programmed in 'RGDV Data Set A' (tomo time input active only in combination with option 'Automatic input of tomo times')
    - has to be programmed in connection with a Bucky Controller System with TOMO, which gives access to the 16 tomo times in the System (tomo time input only in combination with option 'Automatic input of tomo times')
    - if 'yes' is programmed exposure time ⊕⊖ corrections are not possible on the desk

  - **Disable time override:**

    no = ok

    yes = disables exposure time ⊕⊖ corrections on the desk

    if a RDGV is 'Used for tomo' = yes, then the time override is automatically disabled

  - **Tube power factor [%]:** range =1...100% of max kW, effects all filaments of a tube

  - **kV steps:**

    Doseequivalent 6% kV steps ≡ 25% density steps

    values: 40, 41, 42, 44, 46, 48, 50, 52, 55, 57, 60, 63, 66, 70, 73, 77, 81, 85, 90, 102, 109, 117, 125, 133, 141, 150 kV

    Min and max kV values will appear as programmed in the 'Tube Limits' table.

    Single = 1 kV steps in-between the programmed limits kV_min and kV_max

- **mAs steps:** 25 % (default)
  12 %
  6 %

- **mA steps:** 25 % (default)
  12 %
  6 %

- **time steps:** 25 % (default)
  12 %
  6 %

- **Density steps:** 25 %
  12 % (default)
  6 %

The density correction displayed on the desk only shows e.g. -1 or +2. This -1 or +2 can stand for (a) step(s) of 6%, 12% or 25%.
All RGDV's should have the same correction factor to get the same result when used. More explanation in 'Change APR Data Set'.

- **Density correction (6% steps):** range = - 8 ... + 8 (see !!!! page 17)

  - For individual stand or other registration device related corrections
  !! No correction should be programmed before the proper density in the 'Dose Rate Control' part has been adjusted adjusted.

- **Underexposure display (non automatic techniques):**

  yes The underexposure sign is blinking, if the exposure has not been terminated by the generator (FU_mA for all non AEC techniques), e.g. the handswitch has been released too early or the tomo time switched by the table is shorter than the programmed exposure time.

  no No underexposure display comes up under the following conditions:
  - 'no' **must** be programmed for tomo; times switched from a tomo stand might be different to the programmed APRT time, but the tomo time of the stand must be within a tolerance of the programmed desk APRT time - 10 %

- **Tube overload protection:**

  on (default), the tube overload protection is on, load reductions are active

traffic light on contol desk:	green	100% load	tube cold
	green-yellow	100% load	tube warm
	yellow	80% load	medium hot
	yellow-red	64% load	tube hot
	red	0% load	→ **no ready**

  off Desk always ready, PREP and EXPOSURE possible with 100% load, even with red light on.
  Should not be programmed for Radiographic sites.

- **RGDV Interface Assignments**

!!! **Nothing should be programmed in this part if the generator is**
!!! **connected to a Bucky Controller System via System CAN EZX43**

- **Bucky/Tomo 1WA** and/or **2WA**

  - **Decade Bucky 1 (X11)** e.g. EWAX11 and/or **Decade Bucky 2 (X12)** EWAX12

    - **Tomo mode switch:**

      disable= (default) no remote switchover

      enable = enables Bucky/Tomo remote switchover X11 or X12 pin 3-4

      If 'enable' is programmed both Bucky-RGDV **and** Tomo-RGDV have to be programmed (switch related), if only one RGDV is set, the generator hangs up

!!! Only **one** decade (X11 or X12) of each 'Release circuit adaptation unit' 1WA or 2WA can be enabled for Bucky/Tomo remote switch over, if both are programmed there is **no** switch over at all.

    - **Bucky RGDV - switch related:** (*)

      none = ok

      RGDV 1...8

      - activates the recognition of the Bucky Ready contact EWAX11 or EWAX12 pin 9-10
      - defines the Bucky RDGV for Bucky/Tomo remote switchover, if 'Tomo mode switch' is enabled
      - activates the format size correction contact (closed if > 24x24 cm) EWAX11 or EWAX12 pin 1-2,
        !! if no automatic collimator exists, insert a link at pin 1-2 to get access to the side field selection
      - if no Bucky Ready contact exists, but the format size correction has to be active: insert a link at pin 9-10

    - **Bucky RGDV** (*)
    - **Bucky RGDV** (*)

    (*) **three** RGDV's can be programmed at the same Bucky Ready contact

      none = ok

      RGDV 1...8

      - activates the recognition of the Bucky Ready contact EWAX11 or EWAX12 pin 9-10
      - activates the format size correction contact (closed if > 24x24 cm) EWAX11 or EWAX12 pin 1-2,
        !! if no automatic collimator exists, insert a link at pin 1-2 to get access to the side field selection
      - if no Bucky Ready contact exists, but the format size correction has to be active: insert a link at pin 9-10

- **Tomo RGDV - switch related**

  none = ok

  RGDV 1...8

  - activates option 'Automatic input of Tomo times',
    !! if no Tomo Ready contact exists, but the format size correction has to be active: insert a link at pin 5-6
  - activates recognition of the Tomo Ready contact EWAX11 or EWAX12 pin 5-6
    !! if no Tomo Ready contact exists, but the format size correction has to be active: insert a link at pin 5-6
  - defines the Tomo RGDV for Bucky/Tomo remote switchover, if 'Tomo mode switch' is enabled
  - activates the format size correction contact (closed if > 24x24 cm) EWAX11 or EWAX12 pin 1-2,
    !! if no automatic collimator exists, insert a link at pin 1-2 to get access to the side field selection

- **Tomo Time**

  Tomo numbers 1...8 can be programmed in the 'APR Data Set's. Programming the times makes only sense if option 'Automatic input of tomo times' exists (programmed in the CU-function key D38, see STAMMKARTE).
  Every tomo number from 1...8 is linked to one tomo time (depending on the tomo device settings).
  Every tomo time has to be programmed with a time in-between the range of 0.1 ... 6000 ms.
  Tomo numbers 1...8 are directly linked to the tomo trajectories EWAX22 1...8, while tomo times 1...8 are linked to the tomo time input EWAX21 1...8.

*** If tomo APRT's are programmed using option 'automatic input of tomo times': Select every APRT once. For a very short time the default time of an APRT can be seen on the desk, then the tomo time contact overrides the default time. This time must be stored using the desk store function 'reset button + active APRT'. After that the tomo time is fixed. If it is not stored then the default APR time will come up again if the APRT is pushed a second time or if an APR with the same tomo time is selected. The tomo time input only reacts to a dynamic high → low time contact change.

- If tomo is programmed in 'Data Set A + B' then it is not possible to change the exposure time on the desk. If APR with the same tomo time have to be corrected time dependent then an APR with another time has to be selected in-between APR's with the same tomo time to have access to the changing tomo time contact.
- It might happen that three tomo times can be seen on the desk after pushing an APRT button: The first time being displayed is the time stored in the APR. The second time might be tomo time number 1, if all time contacts of the tomo stand are open. If then the tomo time contact is closed, the status change will effect the display of the programmed tomo time.

- **Dose Rate Control**

  - **AMPLIMAT**

    - **Amplimat sensitivity:**

      high Sensitivity of basic interface chamber signal amplifier 4 times higher.
      Only possible with PCB EZ150 version 4512 108 05964 and higher, in this case jumper W4 must be in position 1 (x4).

- 'High' **must** be set in case of **TDC** (**T**omo **D**ensity **C**ontrol) option (only with PCB EZ150 ≥ 4512 108 05964 with jumper W4 in position 1 (x4)).
- 'High' should be the recommended range if all film screen combinations of the system are ≥ 200 (only ≥ 4512 108 05964 with jumper W4 in position 1 (x4)).

low (default) **!! Must** be low in case of PCB EZ150 versions up to and including 4512 108 05963 and versions ≥ 4512 108 05964 if jumper W4 is in position 3 (x1)
'Low' should be the recommended range if at least one film screen combination of the system is < 200 (only ≥ 4512 108 05964 with jumper W4 in position 3 (x1)).

- **Chamber 1** ... 5
  - **Data Set 1** ... 5
    - **DRC Handling / Start Automatic DRC Processing**

- **<OK>** Every empty line of this window has to be filled:
  For PCR/FCR (computed radiograpy cassettes see '<CANCEL>'

FILM	default data	file :	FILM.TDL	(1)
SCREEN		dto.:	SCREEN.TDL	(2)
CHAMBER		dto.:	CHAMBER.TDL	(3)
CASSETTE		dto.:	CASSETTE.TDL	(4)
SYSTEM CORRECTION		dto.:	SYSCOR.TDL	(5)
CORRECTION FACTOR	range = 0.00 ... 9.99			(6)

(1) If the film type is not in the default data list, then select one of the film files: FILM_BL (blue), FILM_GR green), FILM_UV (ultra violet).
Select the one which matches the sensitivy factor S and RLF compensation. **S** is a multiplication factor for the speed type of the screen:
if the screen = 400 and S_film = 0.5, then the total system is 200.

(2) If the screen type is not in the default data list, then another file can be selected: LUMAT.TDL.
This file contains the luminous groups LG with different colors and different speeds.

(3) The following list gives the PEI-No. of the chambers which can be selected from the data file CHAMBER.TDL and the typical dose request values.

		[µGy/V]
typical Hybrid	9803 509	5.86
typical ALC	9890 000	5.24
Bucky	9803 509 10002	5.86
Childrens Bucky	9803 509 10102	5.42
Chest	9803 509 50002	5.86
Scopomat 42/52	9803 509 30202	5.68
Scopomat 63/73	9803 509 30002	5.33
Scopomat 71/74	9803 509 30102	5.16
Neuro Diagnost	9803 509 50102	8.04
Cranio Diagnost	9803 509 50602	8.04
Puck 35x35	9803 509 60002	4.37
Bucky	9890 000 01611	5.24
Childrens Bucky	9890 000 01621	4.81
Chest	9890 000 01661	5.24
Scopomat 42/52	9890 000 01651	5.07
Scopomat 63/73	9890 000 01631	4.81
Scopomat 71/74	9890 000 01641	5.16
Neuro Diagnost	9890 000 01671	7.17

Cranio Diagnost		9890 000 01681		7.17
Puck 35x35		9890 000 01691		3.93
Extremities		4512 102 80261	9803 509 50202	10.05
Extremeties		4512 104 47621		1.14
Junior-	/	4512 103 06661	9803 509 51202	3.32
Diagnost	\	4512 104 47621		1.14
Mammo-	/	4512 127 98802		3.32
Diagnost	\	4512 127 98803		1.40
Mammo-	/	4512 104 18811	9803 509 70002	3.32
UC/BC	\	4512 104 47621		1.40

X-CONSTANT DV=1VOLT

(4) normal cassette (default) Al (factor 1.0)
carbon fiber cassette (factor 1.12)
1/2 screen normal cassette Al (factor 0.5)
1/2 screen carbon fibre cassette (factor 0.56)
factor can not be changed

(5) no correction (ISO9236-1) = linear kV behaviour

low-kV-correction = correction factors kV dependent:

40	50	60	70	80	90	100	120	140	150 kV
0.7	0.78	0.89	1.0	0.99	0.95	0.92	0.94	0.98	1.0

(6) The default value is 1, representing a density of 1. If no PC-hardkey exists, this field is the only chance to modify the density of the programmed FSC. If the value has to be changed to the desired density after the dose and density measurement, the whole window has to be programmed again, unfortunately. If the PC-hardkey exists, use the function 'Start Automatic DRC Processing' -> '<CANCEL>' and keep the correction value on 1, if not, use the following formula:

$$\frac{\text{desired density}}{\text{measured density}} = \text{new [CORRECTION FACTOR]}$$

The name of the FSC is the abbreviation of the resulting speed and the colour of the film screen combination. There might be names like 'B400' for a blue 400 combination or 'G200' for a green 200 combination.
The name can be changed (only with the PC-hardkey), see 'Start Automatic DRC Processing = <CANCEL>'. The name **must** be changed if different film screen systems with the same resulting name exist. A change from the first G200 to a second one can not be recognized on the desk.
Combinations of systems with different colours can not be programmed (even if they exist).

If a film screen combination is used with different chambers and a data set is programmed once, then it can easily be copied to other chambers/data sets (only with the PC-hardkey):
Use the '<CANCEL>' function, the data screen will be displayed. With the 'Save' function <F3> the data screen can be loaded to the disc/harddisc with any file name (e.g. Ch1D1). If a data set is opened on another chamber the stored file can be loaded with <F4> + file name to the open data set. Transmit the dataset with <F2> thereafter.

- **<CANCEL>** or: use <ESC>

Some values in the data sets of the chambers can be changed, others should not be changed (kV dependent characteristics).

If PCR/FCR cassettes are used, type the desired sensitivity (speed) in the name field. Select the 'Dose Request Chamber [µGy/V]:' value from the list above and type it in. The value 'Dose of FSC [µGy]:' must be calculated: 1000 / [speed value]. (1000/200_speed_system = 5).

Abbreviation:

The name of the film screen combination can be changed into every 6 digit string.
An FSC can be erased by filling the name field with blanks, but: !! There should **never** be a gap in-between the FSC data sets of a chamber. If only one FSC is used, it **must** be on data set 1, the second **must** be on 2 etc. If e.g 4 data sets are active and the 1st will be 'blanked', all FSC's are no more accessable and AEC is no more available for this RGDV.
If any FSC will be removed from the last position all APR linked to this FSC have to be changed to any other still existing FSC, otherwise no FSC will be displayed on the desk. When these APR are changed to another FSC the background mAa values have to be adapted to the FSC sensitivity.

Dose Request Chamber [µGy/V]: range: 0.50...32 µGy/V

Dose of FSC [µGy]: range: 0.45...100 µGy

The initial value 'Dose of FSC [µGy]:' of the automatic DRC processing has been calculated for a density of 1. It can be changed into any other desired value, e.g. 1.5.

$$\frac{\text{desired density}}{\text{measured density}} * \text{default [Dose of FSC]} = \text{new [Dose of FSC]}$$

If an APR is selected with AEC technique the exposure data on the desk will display the abbreviation of the FSC and a 'zero' with a triangle for the density. This 'zero' is the basic value for the desired density. It does not change even if the value for the [Dose of FSC] will be modified.

- **Fault Exposure Detection**

  - **AEC**

    off = (default) no 4% dose supervision at 10% of the backup exposure time, automatically off after APR overriding

    on = At 10 % of the backup exposure time (APR mAs value) DRC detects if at least 4% of the expected dose have been measured. If not, the exposure will be switched off by CU.

  - **TDC**

    off = (default) no 4% dose supervision at 10% of the backup exposure time, automatically off after APR overriding

    on = At 10 % of the backup exposure time (APR mAs value, tomo time > 1000ms ,not before 250ms) DRC detects if at least 4% of the expected dose have been measured. If not, the exposure will be switched off by CU.

- **Application Limits**

  - **X-Mode Limits**

    Limits can be modified within the range of the value fields. Values should not increase the local limits. The 'Max. Time Limit' of 60000ms is not yet available, only 16000 ms.

  - **Thoravision Limits**

    Thoravision not yet available.

- **Human Interface**

  - **Select Language** — **English**, **German**, **French**, **Spanish**: Messages like 'door open', 'menu' etc. and language charactes (letter list see INSTALLATION 12..1.) are related to the programmed language.

  - **APR Data Set**

    - **Select APR Data Set**

      Select any APR on the desk, the name will be highlighted. After <Return> on the PC the APR No. will be displayed on the PC screen. This number can be used for 'Inquire APR Assignments'.
      If this 'Select APR Data Set' window is transmitted with <F2>, it allows to look into the complete APR data set if the following 'Change APR Data Set' command will be used.
      (It is **not** possible with the default 'Test APR'.)
      Any APR No. in-between 1 and 1024 can be typed in, no matter if this APR No. is assigned to any RGDV. When using 'Change APR Data Set' thereafter one can see the default APR data set or a modified APR.

    - **Change APR Data Set**

      This function opens the window to change the complete APR data set. Data marked with a ⊗ can only be changed in this window via PC.
      All other non marked data can be changed on the desk and saved via the button combination 'Reset (hold it) + the highlighted APR'.
      If this 'Change APR Data Set' function is used with e.g. APR No. 135, it will always change back to APR No. 1 after a generator cold/warm reset. In this case the 'Select APR Data Set' command has to be used before to get the actual highlighted APR data set.
      (Change APR is **not** possible with the default 'Test APR'.)

      - ⊗ **APR number:** is just a (random given) pointer

        This number can be used to copy a data set into another data set. In that case the destination APR number ('Select APR Data Set') has to be filled in the 'APR number' field and transmit <F2>. The 'source' data set does not change.
        To move an APR data set copy a data set to the desired destination and delete the source APR data set afterwards with 'APR deassign'.
        There has to be an active destination APR. Error 00BR will come up if a data set is loaded/copied to an APR which is not assigned to any RGDV.

      - ⊗ **APR name:** 16 characters are possible
        If special letters are needed (language dependent) see INSTALLATION 12.1 letter codes.

If APR data are changed on the desk the two last digits of a 16 character string will be used to indicate '_*' = 'overriding'.
Example: **[infant 10-15 yrs]** will change into
[infant 10-15 y *] after overriding.

- **Focus:** **small** = ok
  middle = there will be a 3 focal spot tube
  large = ok
  vario = is a virtual focal spot, its size (tube type dependent) inbetween large and small focus can be selected via the 'Vario focus ratio',

- ⊗ **Vario focus ratio:** range: 20%, 35%, 50% (default) , 65%, 80% of small focus

  Sets the ratio of small and large focus, for tubes with superimposed focal spots, preferred types = SRO25/50, SRO33/100, SRO09/50, RO17/50.
  The ratio should be typed in the 'APR name' field at the end of the line. Example: 'Thorax_ap____50%'

- (⊗) **Dose measurement field (left):** on/off
  Dose measurement field (middle): on/off
  Dose measurement field (right): on/off

  At least one of the measuring fields must be 'on' in an APR to have access to AEC technique even if the 'Preferred technique' is set to 'No AEC technique'; a chamber must be programmed in 'RGDV Data Set A' +'Dose measurement input'.
  The default APR data set [### APR name ###] has all 3 fields 'on'.
  Some customers like ho have 'technique APR's' only. In that case switch 'off' all fields so that there is no way to change to AEC technique if AEC is possible in the same RGDV/menu/page.

- ⊗ **Preferred technique: Non automatic**

  If this APR will be selected, one of the three 'No AEC technique's will be displayed on the major exposure data display.
  With the 'mA-s' technique button on the desk one can switch over from kV-mA-ms (LED on) to either kV-mAs or kV-mAs-ms technique (LED off), depending on what has been programmed.
  If a 'Dose measurement input' is programmed in 'RGDV Data Set A' and at least one 'dose measurement field' is 'on' this APR can be switched over to AEC technique, which will cause the overriding sign ' *' coming up.

  Automatic

  AEC/TDC technique will appear when this APR is selected (AEC technique button LED and 1...3 measuring field LED's on).

*** All predefined APR data sets from the disc are programmed for a 400 speed system. If then e.g. a 200 speed system exists, all non AEC technique values (e.g. mAs) have to be doubled, if an 800 speed system exists, the mAs values must be devided by 2.

- ⊗ **AEC technique:**

  AEC falling load kV — the mA start value of the falling load exposure will appear in the 'Exposure data I [mA]' field

  AEC fixed current kV-mA — the fixed mA value has to programmed in the 'Exposure data I [mA]' field

  Select kV-mA-ms in 'No AEC technique'

  TDC (Tomo Density Control) (option, see STAMMKARTE)
  the TDC start mA value has to be programmed in the 'Exposure data I [mA]' field

  Select kV-mA-ms in 'No AEC technique'

- ⊗ **No AEC technique:** = all non Amplimat techniques

  Two of the three 'No AEC technique's are available in every APR.
  If either kV-mAs or kV-mAs-ms technique is selected one can switch over to kV-mA-ms technique pushing the mA-s button on the desk.
  If kV-mA-ms technique is programmed in the APR and it will be 'deselected' by pushing the mA-s button (LED off) it only changes to kV-mAs technique
  The preferred 'No AEC technique' after AEC-deselect can be changed on the control desk with the overriding-save function.
  !!! If kV-mAs-ms technique is selected as preferred it will change to kV-mAs if the APR data set has been modified on the control desk and has been saved with kV-mA-ms technique **!!!**

  kV-mA-ms technique (RUIT) (Radiographic kV-mA-s), choice of kV, mA and ms parameters

  Must be selected in case of 'AEC fixed current kV-mA' and 'TDC (Tomo Density Control)' techniques.

  kV-mAs technique (RUQ) (Radiographic kV-mAs), choice of kV and mAs parameters

  kV-mAs-ms technique (RUQT) (Radiographic kV-mAs-s), choice of kV, mAs and ms parameters

  This technique is very helpful for tomography. Exposure time and mAs can be selected individually, depending on the tomo figure and the organ & patients size.

  Time ⊕⊖ selection is not possible if RGDV is programmed 'Used for tomo = yes' in 'Data Set B'. Then time selection is via tomo time input (decades or Bucky controller).

  Depending on one of these 3 techniques only the relevant parameters in the following 'Exposure data nn' have to be modified. All other parameters will be calculated by the generator itself after transmission with <F2>. If the same APR data set will be called again, the changes in the 'slave values' can be seen.

*** All predefined APR data sets from the disc are programmed for a 400 speed system. If then e.g. a 200 speed system exists, all non AEC technique values (e.g. mAs) have to be doubled, if an 800 speed system exists, mAs values have to be devided by 2.

- ⊗ **Tube current max. factor [%]:** range = 1...100% (default 100 %)

  The max emission current can be modified within the above range.
  The reduced current (see 'Exposure data I [mA]') can be the start mA value of the AEC exposure. It will be a constant value during the exposure until it comes to a point where the mA have to be reduced (falling load) within 4000ms. The mA value as the result of the % reduction is only valid for one kV value. With the change of kV the mA value also changes.
  The mA value can be seen if the APR data set screen has been transmit with <F2> once. Call the same data set again and the calculated mA value appears.
  Another way to see the mA is on the desk: Push the APR button, switch off AEC. The background technique will come up. In case of kV-mAs or kV-mAs-s push the mA-s button to switch over to kV-mA-ms technique. The displayed mA is the value which is the one step below the max value in the row of the programmed mA steps (see 'RGDV Data Set B'). Now push the mA⊕ button to get the max mA value. This is the same as in the data set on PC.

  If an APR with small focus will be changed by pushing the large focus button the mA⊕ has to be pushed until the max value is reached. A change from large to small will immediately display the max mA.
  The calculated mA value should be typed in the APR label, so that the customer gets a chance of minimum selection criteria. One should tell him that the mA value changes with the kV⊕⊖ and focus selection.
  !! The modification of the max factor will lead error 00L$ if the resulting mAs value is below 0.5 mAs.

- ⊗ **PSC U thin (dose equivalent steps):** range = 0...5

  small 'patients size correction' kV

- ⊗ **PSC U thick (dose equivalent steps):** range = 0...5

  large 'patients size correction' kV

- ⊗ **PSC Q thin (6% steps):** range = 0...10 !!!! see page 17

  small 'patients size correction' mAs

- ⊗ **PSC Q thick (6% steps):** range = 0...10 !!!! see page 17

  large 'patients size correction' mAs

- ⊗ **PSC density thin (6% steps):** range = 0...10 !!!! see page 17

  small 'patients size correction' density correction

- ⊗ **PSC density thick (6% steps):** range = 0...10 !!!! see page 17

  large 'patients size correction' density correction

!!!! = Depending on the step rate of **mAs-** and **density-correction** programmed in 'RGDV Data Set B' these correction values must have an even factor with the basic step rate:
To get a correction of one mAs-correction step 25 % (Data Set B) four 6%-steps have to be programmed here.
To get a +1 density step displayed two 6%-steps have to be programmed here if 12%-steps are programmed in 'Data Set B'.

- **Exposure data U [kV]:** range = 40...150 kV or what has been programmed under 'Tube limits'

If full range is not available, check 'Tube limit' settings.

- **Exposure data I [mA]:** range = 0.1...2000 mA

Depending on the tube type, focal spot, selected technique and all reduction factors; this value can be a master or slave value.
The result of [mA]*[ms] must always be ≥ 0.5 mAs.

If total mA range is not available, check 'Tube limit' settings.

- **Exposure data Q [mAs]:** range = 0.5...1000 mAs

Depending on the tube type, focal spot, selected technique and all reduction factors; this value can be a master or slave value.

If total range is not available, check 'Tube limit' settings.

- **Exposure data t [ms]:** range = 1...16000 ms

Depending on the tube type, focal spot, selected technique and all reduction factors; this value can be a master or slave value.
The result of [mA]*[ms] must always be ≥ 0.5 mAs

If total range is not available, check 'Tube limit' settings.

- **Exposure data density (6% steps):** range = -16...+16

Depending on which step rate has been programmed under 'RGDV Data Set B', explanation see 'PSC density thick' !!!! page 17.

*** If APR with AEC are linked to a certain Film-Screen-Combination the basic density value of this FSC appears as a 'zero', because this 'zero' (X) - value is based on a density of 1. Even if the density has been modified to e.g. 1.5 the 'zero' (X) remains on the major exposure data display on the desk.
There are organs where the 'zero' density is the right one, but also some where an X-2 or an X+3 correction must be programmed. SCP and Medio CP are based on 12% steps for every ±1 correction, so should the Optimus be programmed in 'Data Set B'. For every ± 1 step based on 12% ± two 6% steps have to be set here.

- **Film screen comb.:** gives the selection of all available FSC names programmed under the chamber linked to the RGDV where this APR is assigned to

If 'Predefined Assignment' APR's or old (backup) APR data sets are loaded to the RGDV's, the FSC of 'Data Set 1 of Chamber (1..5)' will initially be linked to **all** APR's.
If another FSC shall be used the change can be done here or via the overriding/save function on the desk.

*** All predefined APR data sets from the disc are programmed for a 400 speed system. If then a 200 speed system exists, all non AEC technique values (e.g. mAs) have to be doubled, if a 800 speed system exists, the mAs values must be devided by 2.

- ⊗ **Tomo Number:** 1...8 (Release circuit adaptation unit 1WA or 2WA)
  1...16 (Bucky Controller 1 or 2 via CAN)
  default = 1

  Only relevant if option 'Automatic Input of Tomo Times' is programmed in function key D38 on CU (see STAMMKARTE on kV_power cover plate or 'Options' under 'Faultfind').

  Activation under 'RGDV Data Set A + B', 'RGDV Interface Assignments' and 'Tomo Time' for the programmed 'Release circuit adaptation unit'. Then 8 tomo numbers are available.

  In case of Bucky Controller System with TOMO 16 tomo times are available, but for Tomo Nr. 10 e.g. in the system Tomo number 11 has to set in the APR data set.

  If no tomo unit is present: ignore.

  Tomo via decades (1WA or 2WA):
  If tomo APRT's are programmed using option 'automatic input of tomo times': Select every APRT once. For a very short time the default time of an APRT can be seen on the desk, then the tomo time contact overrides the default time. This time must be stored using the desk store function 'reset button + highlighted APRT'. After that the tomo time is fixed also in the APRT. If it is not stored the default APR time will come up again if the APRT is pushed a second time. The same happens if an APR with the same tomo number is selected. The tomo time input only reacts to a dynamic high-low status change of the time contact. The times can only be changed in the data set via PC or if another time will be selected to switch back to the same tomo time.
  It might happen that tomo time 1 comes up on the desk for a very short time. This is dependent on the delay times in-between the switch off of the old tomo time contact and the switch on moment of the selected tomo time contact.

  Tomo via Bucky-controller:
  If the default programmed tomo times in the APR data set are different to the tomo times send by the bucky system the default APR time appears for a very short moment, then the time will be overridden by the contoller message. If so, use the store function of the desk to fix the proper tomo time in the APR data set.

- ⊗ **Spectral Filter:**

  gives a selection of the three filter types of the GALILEO collimator via bucky controller

  no filter
  2 mm AL
  0.1 mm CU + 1 mm Al
  0.2 mm CU + 1 mm Al

- **Inquire APR Assignments**

The OPTIMUS has 1024 APR. Once activated, every APR data set gets an APR Number. These numbers are given without any special system (it's more ore less random). If a certain APR number is known, typed in and transmit with <F2>, the window coming up gives the APR name, the RGDV and menu where it is assigned to (blank in case of none), the page, line and column of its position.
If an APR number is typed in which has not yet been 'opened' the location fields (RGDV, menu, submenu, page etc.) are empty.
To get the APR No., just select any APR button on the desk. Then use 'Select APR Data Set'.
(It is not possible with the default 'Test APR'.)

- **RGDV related Assignments**

  - **RGDV 1** ... 8

    - **Predefined Assignments**

      The Load Data from Disk window offers all predefined APR data sets of the installation disc or other predefined files (or use 'APR manager' APRWORK.EXE to create customized data files).

      The name of these files is A******.TDL.
      A***M****.TDL files are for tubes with one filament only (_RO30), A****V***.TDL files for generators with VARIO focus option, A****V9**.TDL with VARIO focus option especially for SRO09/50.

      The files may contain data sets in a window Available Examination Unit Type :

BUCKY GR	Bucky table APR under a **group** (menu) layer
BUCKY PA	Bucky table APR **paging** (scroll through the APR pages)
WALLSTD GR	Bucky wallstand group
WALLSTD PA	Bucky wallstand paging
FREE GR	Free technique (non AEC) group
FREE PA	Free technique (non AEC) paging
TOMO LT/HDH	Tomograpy group
TOMO LIN/PA	Tomography paging

      After the transmission of the APR from the PC to the generator 'waiting' will appear on the PC screen. Now the generator is calculating the source data from PC to the individual installation parameters (generator power, tube type etc.). The generator **must not** be reset before 'waiting' disappears, otherwise APR which have not yet been calculated at that moment are lost.

      RGDV related backup files (APR_BAKx.TDL, x=1...8) can also be loaded to the generator with the same 'Predefined Assignment' function.

      It is possible to load all RGDV with predefined APR data sets and make one generator reset at the end of all loading procedures. After every reset all newly loaded APR and menus appear on the desk.
      It is not possible to load a second data set on top of an existing data set. In that case the old RGDV menu/APR structure has to be erased before with 'Delete Menu'.

      With the XRGSCOPE - File option one can use the editor to modify the predefined APR data sets or backup data sets (e.g. to change all APR to large filament in case of a single filament tube).
      This is easier and faster as if every APR will be selected on the desk and the 'Select APR' followed by the 'Change APR' function is used. One advantage is that this can be done on the PC offline the generator.
      The handling is very easy, is is almost similar to the 'Change APR' screen online with the generator. After modification the data set has to be saved with <F3>, the filename could be the same or any other.
      Only data sets with up to 50 APR can be modified. There is no way co change the amount of APR.
      A very much easier way is with the APR-manager APRWORK.EXE.

- **Manual Assignment**

  - **APR Assignment**

    - **Select Menu**

      The menu name field is as long as the longest menu name. If the field is only two digits long and only one field is displayed after <RETURN> there is no menu.
      If no menu structure exists, proceed directly to 'Assign APR'.
      If APR's shall be in a menu structure, assign this(these) before in 'Menu Assignment'.

      If an APR shall be added to a menu this has to be selected first. Transmit this window with <F2> after selection.

    - **Assign APR**

      The window will offer either '### APR name ###', which is the default data set or, if there has already been another APR structure, some of the deassigned APR's (see 'APR Deassign').
      It indicates (automatically) the position where it will be loaded to:
      page, line and column.

      The order of APR positioning on a page is always like this:
      column 1 line 1,2,3,4
      column 2 line 1,2,3,(**)

      (**) - if APR's are programmed under a menu, the next APR will be assigned to the next page column 1 line 1, this position column 2 line 4 indicates 'menu' to come back to the menu screen
      - if no menu structure exists column 2 line 4 will be the next APR position, followed by the next page column 1 line 1 etc.

      Any position can be typed in. If the position is already occupied, an error will come up.
      If only one APR on position column 2 line 3 exists under a menu structure, the next APR position will be on the next page, even if all other postitions on this page are free. The automatically given positions can be changed to fill up empty positions.
      Do not assign an APR on position column 2 line 4 under a menu structure, it will be transmitted to nowhere.

  - **APR Deassign**

    - **Select Menu**

      The menu name field is as long as the longest menu name. If the field is only two digits long and only one field is displayed after <RETURN> there is no menu.
      If an APR shall be removed from a menu structure this menu has to be selected first.
      If no menu structure exists, proceed directly to 'Deassign APR'.

    - **Deassign APR**

      'Deassign APR' gives a selection of the APR programmed under a menu or a paging structure (it does not matter if there are empty fields in-between the APR).
      Deassigned APR are not totally lost. There might be access to deassigned APR under 'Assign APR' if the amount of APR is > ≈ 500.
      Deassigned APR can still be seen on the desk if no generator warm reset was made after deassignment, but they are no longer accessable.

- **Menu Assignment**

  - **Select Menu**

    There are structures possible with a menu layer first and a second submenu layer.
    Creating submenu structures: first assign the main menus under 'Assign Menu'. Then 'Select Menu' and program the submenu names under the main menu with 'Assign Menu'.

    !!! At least one APR has to be programmed under one of the lowest menu or submenu layer to have the structure fixed.
    If once an APR is programmed under a menu there is no further submenu layer possible.
    The 'Select Menu' name field is as long as the longest available menu name. If no menu is accessable there will be the message 'The requested table is empty'.

  - **Assign Menu**

    This function can be used to assign menus to an empty RGDV. It can also be used to add a menu to an existing menu structure (in the same layer) or to create / add submenus.

    Menus can not be assigned if a paging structure with APR only is programmed.

    Submenus can not be assigned if APR's already exist under a menu. In this case no menus are offered under 'Select Menu'.

- **Delete Menu**

  This function allows to delete the selected menu including the whole structure under it. This can be an APR layer only or submenus including all APR's.
  The function offers all menus under a RGDV including an empty field on top. If this empty field will be transmitted with <F2> the complete menu/submenu/APR structure will be erased. After generator reset 'test APR' will appear on the desk. This function should be used to clear a RGDV before new predefined APR data sets are loaded or the 'Accept' -> 'Restore' (to reload backup files) function is used.

- **Move Menu**

  Menus or submenus can be moved within its layer to a free position (column and line), which has to be defined before. Moving menus to other RGDV's is not possible.

- **Rename Menu**

  The menu name can be changed into everything desired (characters see INSTALLATION chapter 12.1).

- **External APR Assignments**

  - **Device Interface 1**

    RGDV key 1: position 1
    RGDV key 2: position 2
    APR key 1...6 **(0 no APR):** positions 3..8

    1 2
    3 4
    5 6
    7 8

    Device Interface 1 is linked to the 'Release circuit adaptation unit' 1WA. It can be programmed with two of the activated RGDV's. Six APR's of every activated RGDV

can be assigned to the six buttons 3...8. To get the 'APR key'numbers use 'Select APR'.
The APR numbers must be entered in the RGDV # where they are assigned to. The two RGDV keys appear in all RGDV's.
If an assigned RGDV and/or an assigned APR is selected on the control desk, the RGDV/APR button will light up in the external APR module.

- **Device Interface 2**

  APR key 1...8 **(0 no APR):** positions 1..8 = keys 1..8

  8 APR of each activated RGDV can be assigned to the 8 APR keys (→ max 64 !!).
  It is recommended to use one RGDV only.
  If an assigned APR is selected on the control desk, the APR button will light up in the external APR module.

- **APR modifiable by User**

  Yes = all data which can be overridden on the desk can be stored with the save function 'Reset + APR button'

  No = the save function after overriding is disabled, should be programmed if the MENU/APR structure is stable after a certain time or if there are 'gamblers' on site

Optimus (XRG90) → Adjust

- **Adjust**

  - **Tube Adaptation**

    The tube adaptation includes
    1) the measurement the mA offset of the kV measuring circuit
    2) the measurement of the individual standby filament current
    3) the kV dependent filament/emission current bahaviour
    4) the boost adaptation

    in one procedure.

    The generator should be in a ready condition. Select a RGDV with free cassette programming (no grid sync contact).

    Press <RETURN>

    An opening screen asks to wait 20 seconds after the screen coming up thereafter has been <TRANSMIT> with <F2>.

    Tube: **1st Tube**
    2nd Tube
    3rd Tube

    Focus: **small**
    medium a tube with a (third) medium filament does not exist yet, it is **not** Variofocus
    large

    After <TRANSMIT> of the screen the green ready disappers from the desk for 20 seconds. The 'Test' sign on the right side of the major exposure parameter display will change to 'Adap', normal exposure parameters like film-screen-combinations will disappear during a readaptation procedure to display 'Adap'.

    The green ready returns, the first data set **40kV 0.00mAs** comes up, which is the exposure data set to measure the mA measuring circuit offset.
    After about 30 sec **40kV 1.5mAs** will be switched for 6 seconds to measure the individual standby filament current.
    After 20..30 second a row of exposure with different kV stages are switched (about 120 / filament). 4 min after start of adaptation the boost adaptation takes place. One exposure is for the positive boost (to measure the boost up time), the last exposure of the whole procedure is the negative boost (to measure the blank time). The tube will brake the last time, a beep on the PCand a window on the screen will ask you to reset the generator.

    During the adaptation it might happen, that the procedure stops for a while. The red light of the temperature traffic light lights up. If the TTS (Tube Temperature Supervision) sees a temperature in a critical range it will stop adap for a while to keep adap always in a 100% load range.

    After adaptation all techniques are available and the 'Test' sign disappears.

  - **CAN Auto Configuration**

    Start function: Update Generator Config:

    <OK> gives the command for CU to scan on the internal generator CAN bus and update the CAN member list.
    Minmum configuration of an OPTIMUS:
    FU_mA (EZ119), **FU_kV** (EZ130), **FU_CU** (EZ139), **FU_CIE** (EZ150).

If now an optional **F**unctional **U**nit shall be added (e.g. FU_ADAP = 1WA = PCB EWA102) this command must be given to announce this board on the CU CAN list.
If a generator is getting a new (empty) PCB CU or the CMOS has to be erased for any reason, this function must not be carried out. The CAN member list will be created during the very first switch on.

<CANCEL> or <ESC> nothing changes

- **Area Exposure Product** If the area dose shall be displayed on the control desk the option must exist (see STAMMKARTE) in the function key EZ139 D39 (see 'Faultfind - Power ON Results - Options). The option requires the GALILEO collimator via Bucky controller.

- **Specific Yield of Tubes**

  - **Specific Yield of Tube 1...3**

    Procedure to measure and modify the specific tube yield see INSTALLATION 16. The default yield data table is on the installtion disc: REF_YIEL.TDL.

  - **Add Filter Correction Table** to adjust deviations of the default filter correction tables of the homogenous GALILEO collimator filters

    - **2 mm AL** The default data table is on the installtion disc: REF_2AL.TDL.
    - **1 mm AL + 0.1 mm CU** The default data table is on the installtion disc: REF_01CU.TDL.
    - **1 mm AL + 0.2 mm CU** The default data table is on the installtion disc: REF_02CU.TDL.

  - **Wedge Filter Correction Tables** to adjust deviations of the default filter correction tables of the GALILEO wedge filters
    Available with Release 3.

    - **Wedge 1** The default data table is on the installtion disc: REF_WED1.TDL.
    - **Wedge 2** The default data table is on the installtion disc: REF_WED2.TDL.
    - **Finger Wedge** The default data table is on the installtion disc: REF_FING.TDL.

- **Boost Adaptation** Boost adap is part of the automatic 'Tube adaptation' procedure. If it might be necessary (no reason known yet) this function can be used, normally: ignore.

Optimus (XRG90) → Accept

- **Backup**
  - **RGDV related Assignments**

    RGDV 1...8

    APR Assignments After **Reading** ✳ the PC offers the default backup name **Backup File Name: APR_BAK1...8.TDL**.
    The name can be changed into any other file name.
    The path (harddisc) will automatically be taken into account. It is also possible to type **A:** <RETURN> to load the backup files directly to the floppy disc, even when the XRGSCOPE program is on the harddisc.

  - **CU Complete**

    The default backup name **Backup File Name: CUBACKUP.TDL**
    can be changed into any other file name. A disc space of 235 kByte is required. It takes about 6 minutes to store the data to the disk.

- **Restore**
  - **RGDV related Assignments**

    RGDV1...8

    APR Assignments The path (harddisc) will automatically be taken into account or type in **A:** <RETURN>.
    Load Data from Disk: will offer the default file name **APR_BAK1...8**.

  - **CU Complete**

    Load Data from Disk offers the default **File Name: CUBACKUP.TDL**.
    The path of a harddisc will automatically be taken into account.
    It takes about 15 minutes to restore the data.

    !!! Date and Time must be set after restore is finished. **!!!**

- **Inspect**
  - **Exposure Counter**

tube	number of exposures
1	\ total amount
2	) of small and large
3	/ focus exposures

  - **Type of Tube 1...3**

    Tube name + housing type as programmed from the tube data file.
    No name in: no tube programmed.

Optimus (XRG90) → Faultfind

- **Power ON Results**
  - **Options**

    This screen displays all options programmed in the function key EZ139 D38 (compare with STAMMKARTE on the cover of the frontal kV_power unit).

  - **Internal CAN Configuration**

    This screen displays the actual members on the internal generator CAN.
    Basic units: **FU_mA** EZ119, **FU_kV** EZ130, **FU_CU** EZ139, **FU_CIE** EZ150
    Optional units: **FU_HI** C300, **FU_I/O** 1/2WA102, **FU_ROCO_HS** Y100

    FF = unit not present.
    F0 = optional unit programmed, but no response
    2 = unit present and ok
    01 = no response from basic unit

  - **SW/HW - Versions**

    This screen displays the actual firmware versions **Release, Version** and **Level**.
    For the PCB **C**entral **U**nit it also displays the hardware version.

- **Logging Table**
  - **Error Log**
    - **Error Log Index** gives an overview of the events logged in the FU_CU CMOS.

      Index Max 38 events can be logged. The last event is always in the highest index number. If all 38 lines are filled, line 38 will log the last event and the oldest event (line 1) disappears.

      Code Displays the 4 digit code. The fist two digits represent the error source (**F**unctional **U**nit number, HEX format), the last two digits the event mailed by the unit.

      Date of Error Event entrys should have a regular date and time format. If the date and time column also contains any letters,
      - the clock has not been set
        - after the very first switch on
        - after PCB CU exchange
        - after NV-RAM = CMOS erase of CU
        - after 'Restore' of 'CU Complete'

      Error Explanation gives a brief explanation of an event.

    - **Select Error Detail** Index [ ]

      After looking through the 'Error Log Index' one can enter the index number of an event to get te details. The last index number is automatically in the entry field.

    - **Error Log Detail**

      Not every functional unit supports detailed event logs. If event source is not CU, kV or mA, **FU not supported** will be displayed.

- **Error Datail of CU**
  - **Error Info** to be continued
  - **Program Trace** to be continued
- **Error Detail of kV**
  - **Error Info** to be continued
  - **Program Trace** to be continued
  - **HW Set Value** to be continued
  - **Read HW Values** to be continued
  - **Error Specific Info** to be continued
- **Error Detail of mA**
  - **Error Info** to be continued
  - **Actual Status** to be continued
  - **Status Trace** to be continued
  - **HW Set Values** to be continued
  - **Read HW Values** to be continued
  - **Error Specific Info** to be continued

- **Error Log Clear** **Start function: Clear Error Log**

  If send with <OK> all entries are erased.

- **X-Ray Log**
  - **Tube Temperature Supervision Logging**
    - **Tube Temperature Supervision Temperature Log**

      The tube temperatures are supervised by the TTS calculation model. Every second the temperatures are revised and updated in this table. Overload flags (see part: 23456) are tube and housing type dependent. Tables disappear with switch off, but actual temperatures will be calculated and updated during switch on or warm start.
      After a long switch off period (over night) all temperatures should be at 20°C (basic value).

      time time table in seconds
      tube tube number (1...3)
      T(2) spot temperature
      T(3) track temperature
      T(4) anode disk temperature
      T(5) rotor temperature
      T(6) oil temperature

part: 23456	0	0	1	0	0	0	0	0
	↕	↕						
traffic light on =1	yellow	red						
overload at temperature = 1				T(2)	T(3)	T(4)	T(5)	T(6)
standby = 1, EXON = 0			1/0					

- **Tube Temperature Supervision Load Log**

  This Tube Load Table displays all loads to the tube and housing. The table disappears after switch off or warm start.

time	in seconds
tube disk energy	[Ws] parameters
peak load	max peak oad in [W]
rotor energy	acceleration and brake energy in one package in [Ws]
focus	filament used for the exposure

- **Tube Temperature Supervision Error Log**

  to be continued

- **Dose Rate Control Logging**

  - **Read Actual Status**

    to be continued